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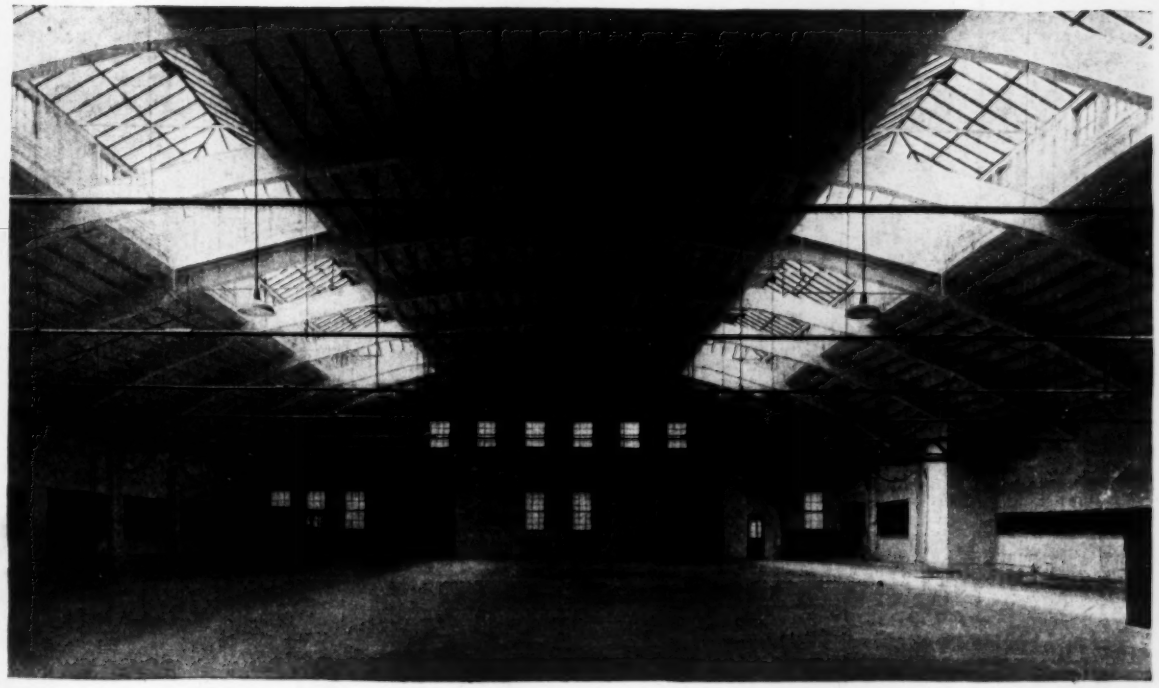

Concrete Roof Arches of 103 Ft., 7½ In. Span for Chicago Garage

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By Harry N. Jenks

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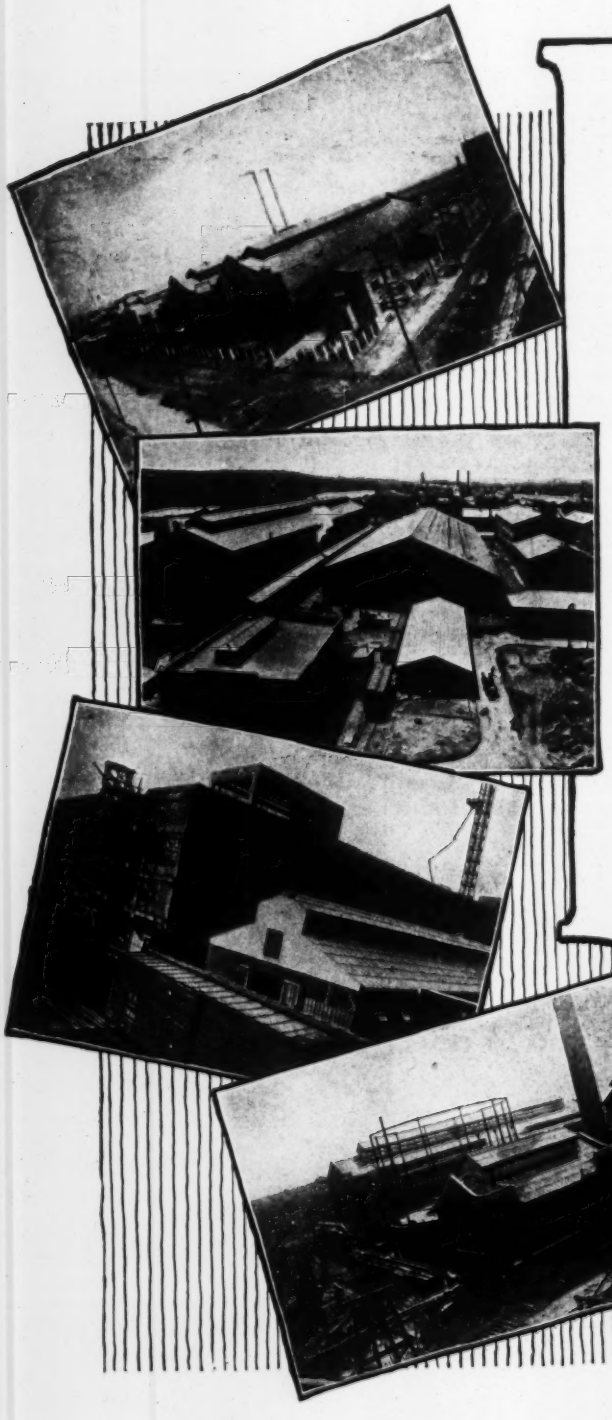
Interstate Water Conflicts and Their Prevention
By R. I. Meeker



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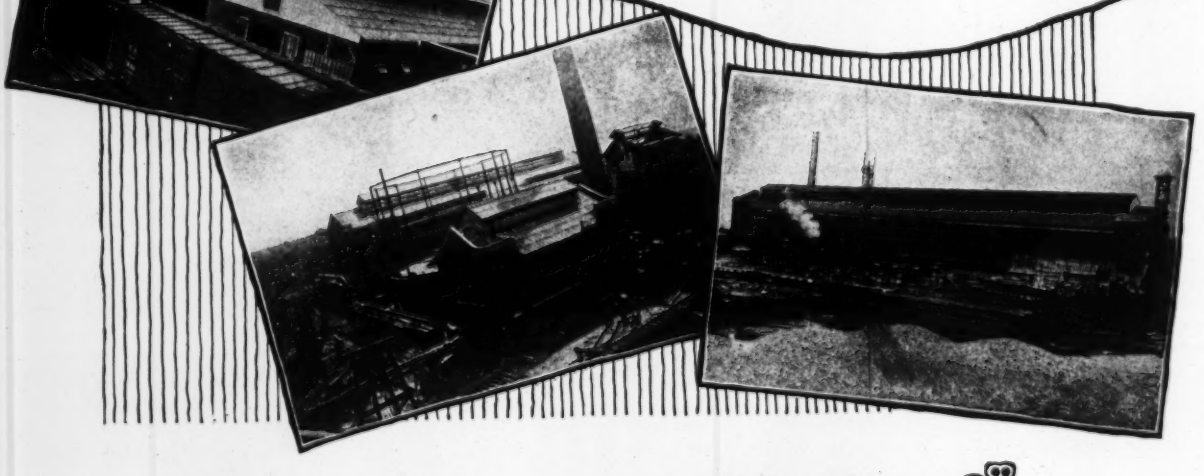

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ENGINEERING NEWS-RECORD

DEVOTED TO CIVIL ENGINEERING
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Experimental Data

FEW hydraulic engineers know of the many experimental investigations that are continually under way by the engineers of the U. S. Reclamation Service. The résumé of this work on p. 161 is impressive. The main office of nearly every private irrigation project has in its files similar valuable experimental data but unfortunately much of it never gets beyond the files.

World Economies

THE pessimist who believes the engineer's regard for economics must have changed his attitude if he listened on Thursday night of last week to the address of Francis H. Sisson, vice president of the Guaranty Trust Co. of New York, before a packed auditorium at the smoker of the American Society of Civil Engineers. He spoke on world economics, on the reasons for our present business situation and that of Europe, on the fundamental conditions here and upon the business future. He was applauded to the echo; seldom has any speaker before a general meeting of the society received so enthusiastic approval of his effort. It is a great regret that the address was not taken stenographically and we trust that Mr. Sisson can be induced to put it in writing so that engineers throughout the country may have the same benefit and pleasure as was enjoyed by those who heard it. It's reception was proof that engineers will gladly take more of the same kind of information.

The Cement Inquiry

ASK a large number of engineers and contractors whether there is collusive fixing of cement prices, and the answer from many of them, possibly from most of them, will be yes. This being quite a general opinion, the quizzing of the cement manufacturers by the New York legislative committee was viewed with much approval. This approval was the more hearty when the press reports indicated that the cement men had "been found with the goods." Examination of the testimony in full, as is set forth elsewhere in this issue, fails to substantiate the impression that a case was made against the cement manufacturers. Surely it was shown that there was in effect—uniform prices—that *might* have come from collusive control, but there was absolute failure to show that these uniform prices *did* result from collusion. The cement manufacturers had an explanation for the uniformity, and that explanation was not controverted by other testimony. Obviously, if there was failure to prove price fixing, there was also failure, because there was no opportunity afforded, to prove that there was no price fixing—evidence of uniform prices on the one hand, and the manufacturers' explanation on the other. The point is this: no matter what was the cause of uniform prices—whether collusion or mere competition on a standardized product—the Lockwood investigation has failed to disclose it.

The Sacramento Underdrain Tests

BASED on the results of experiments on perforated-pipe filter underdrains conducted at Sacramento, as detailed by Harry N. Jenks on p. 162, designers may now feel warranted in departing from precedents established fifteen years ago. The theory that small holes closely spaced are necessary seems to be fairly well exploded. So long as the ratio of length of a lateral to its diameter lies between certain limits, the uniformity of discharge regardless of rate of wash is maintained. From the practical standpoint this means dollars and cents saved. For a 4-in. size a 16-ft. lateral may be used, thus materially increasing the size of bed to be operated from one stand. Similarly, the indicated permissible increase in the size of perforations and their spacing is a distinct economic advance. Fewer pipe units have to be handled and fewer points need attention. The small size of the Sacramento plant limits the size of filters it is advisable to build but in a large plant larger sized units cut down operation. In the design of underdrains there seems now no limiting factors within reason and the larger the size of filter units the cheaper will be the installation per square foot. The Sacramento tests show anew that research pays. The results of the questionnaire on filter operation presented in *Engineering News-Record*, Nov. 11 and 18, 1920, point to several other important filtration problems that need attack.

Two Earthwork Hints

SETTLEMENT and slipping of new railway fills are commonly regarded as inevitable occurrences, and probably are so under ordinary methods of construction. The engineers of an English railway having to build large clay fills and wishing to eliminate supplementary work after completion made a study of old banks of the same material and adopted a slope conforming to that of the latter, the inclination decreasing progressively from the top to the toe. This was noted in our issue of Dec. 30, 1920, p. 1284. These fills were made in 10-ft. lifts with slopes dressed to the required shape by means of templates. As the results are said to have filled the expectations the slight additional construction cost is probably well warranted by the saving in trouble and cost of keeping roadbed at grade after the line is in operation. This practice calls attention, too, to the common method of widening fills. It is usual simply to dump material down the slope, without even the simple precaution of roughening the old surface to allow of a bond for the new material. As a natural result much of the material slips directly to the bottom and beyond the slope lines, while such material as remains on the slope is likely to crack and slip down because it is formed in inclined layers. Future trouble and expense may be saved where the new loose material is shoveled or chuted down the slope and built up in successive horizontal layers.

Bad for New York Highways

ONCE again the engineer's claim to political recognition has been ignored. That claim rests upon entirely impersonal grounds. It relates in no way to seeking a job for an individual, but rests upon the broad, sound business basis of putting into an office which requires certain special qualifications a man who, by training and experience, is fitted to administer the duties of that particular post. The newly elected Governor of New York has seen fit to select as his state highway commissioner a man with no experience in the location, design or construction of roads, or familiarity with the vital questions of highway economics which are becoming more pressing each year as the volume of vehicular traffic becomes greater. The chief claims to recognition of the incoming highway commissioner appear to lie in the fact that he has served as state excise commissioner, county superintendent of the poor and chairman of a county Republican committee.

Shortly after his induction into office Governor Miller issued a constructive message stressing the need for efficiency and economy in the administration of the state's affairs. It is impossible for engineers, who are concerned not with politics but with getting the state's highway system built properly and without waste, to reconcile the Governor's words with his acts. They know that the head of one of the greatest state road-building agencies of the country should, first of all, be a technically trained man with a thorough knowledge of the problems which he will be called upon to solve—one who will not require a protracted course of education, depending in length upon his own intelligence and desire to learn, before he becomes in the slightest degree familiar with the principles of highway economics, which, rightfully, he should bring to his office.

We have no grievance against Mr. Sisson, the new appointee. But we resent the Governor's double-faced policy in first pledging himself to businesslike methods in handling the state's work and then naming a layman to a post which demands engineering training. His action is an affront to the entire profession.

The highway commission is one of the state's greatest spending agencies. During the last decade many millions have been put into road construction and maintenence, some of it good and some of it bad. In that time here have been no less than six different highway commissioners, one of whom died in office, the others replacing one another in steady succession. The result has been that New York State has had no stable highway policy and the constant changes in administration have naturally resulted in enormous waste. Only a few days ago New York's Governor naïvely issued a "thrift proclamation." Can he be so lacking in a sense of the ridiculous as to believe that the sham of his present position is not generally apparent?

The proper administration of road-building in New York State is of immediate concern not only to engineers but to the great automobile and motor truck interests, and the public at large. In failing to place a man with engineering training at the head of a department whose work is distinctly of an engineering nature Governor Miller has broken faith. The days of post-war extravagance are over and the people are now watching their pennies. In the matter of the state's road-building program the Governor may rest assured that the electorate is certain to demand an accounting.

The Am. Soc. C. E. Meeting

IT IS WITH the utmost pleasure that we are able to record the happy ending of last week's annual meeting of the American Society of Civil Engineers. There were fears of a storm. In fact, there was a period of theatrical tension, but it passed away happily and the meeting concluded not only without bitterness, but in a spirit of cordiality. There may still be differences in point of view, but they are overshadowed by the desire on the part of all to achieve the best interests of the society. There is good reason to hope that the organization will quickly settled down to its technical work.

Aside from this harmonious conclusion of the meeting, the outstanding event was the election of the candidates on the progressive ticket. It was generally expected that the election would be close. Moreover, the progressives feared that their candidates would be defeated, for they had failed to muster the needed two-thirds vote for the amendment and their proposal that the society enter the federation was defeated. But the election was not close and the progressive candidates won every place.

There is ground for much speculation on the result. It is difficult, for example, to reconcile the votes in the federation and on the election. One of the reasons for the victory of the progressives was probably their possession of the "official" ticket. Another factor that had very great weight was the desire to be rid of all trace of a régime of which a certain individual at New York was commonly held to be the embodiment. The belief that the leaders of the group which sponsored the "nominations by declaration" were in sympathy with that régime and would perpetuate its ideas counted heavily against the "declaration" ticket. As a matter of fact, we feel certain that the great majority of the backers of the "declaration" ticket are not standpatters, but do favor a sound expansion of the work of the society.

If these statements be correct, if all the progressives and all but possibly a small minority of the supporters of the "declaration" ticket are of one mind on the subject, it is the society's duty to eliminate all vestige of the influence of that former régimé.

With the close of this annual meeting the society sets its face forward. All amendments, both those reported by committee and those proposed anew at the annual meeting, will probably be defeated in the letter ballot (as the annual meeting recommended), thus opening the way for consideration of a broad and co-ordinated revision of the constitution at the annual convention in Houston in April. With the good feeling displayed at New York, one can safely look for the same spirit at Houston—a spirit particularly needed in studying the society's fundamental document.

Obviously the new board has heavy responsibilities. Among the first, is the selection of a new secretary. It must get the society back to work. It enters upon these responsibilities, we confidently believe, with general support. There is not now victor and vanquished—but just Am. Soc. C. E. members, all united in an earnest desire to see the society prosper. The fears once expressed by conservatives that a "progressive" board of direction would be a great danger to the society have diappeared. They were never sound fears, of course, but merely the "thunder" of an active campaign. The same

sanity, the same regard for the society's prestige that has always marked the action of the board will prevail.

One further bit of comment is called for—on the size of the vote for officers. A total of 7,008 ballots were counted, representing 80 per cent of the corporate membership, which sets a new record. When it is considered that among the corporate members are about 500 residing outside the United States and Canada and that only a small percentage of these voted, it is probable that the votes of 85 per cent or more of the eligible voters in the United States and Canada were recorded.

This indicates an extraordinary degree of interest. If this same interest or a goodly portion of it could be mobilized for the solid work of the society, great progress could be made. The vote was brought out by intensive work, and past experience indicates that such an interest cannot be sustained. Nevertheless, that it has been once manifested is an indication of a mark at which the management of the society should aim.

Is There a Best System of Heavy Electrical Traction

BETWEEN ten and fifteen years ago electrical engineers were waging a verbal warfare over the relative merits of direct- and alternating-current for heavy traction. The feeling was freely expressed that electrification might profitably wait until the "battle" smoke cleared away. The matter was not simplified by the fact that alternating-current was championed by one of the great electrical manufacturing companies, direct-current by the other.

To obtain a proper perspective of the development of heavy electric traction, still in its infancy but covering a period of about thirty-five years, it is necessary to go back to the 1895 B. & O. tunnel electrification in Baltimore. This was, of course, a 600-volt direct-current installation, nothing else being available at the time. During the following ten years this and other lighter applications of the electric locomotive demonstrated the possibilities of heavy electric traction. When the New York Central in 1902 found it necessary to electrify its New York Grand Central Terminal the well-tried direct-current was adopted, although interest in single phase had begun to manifest itself. The proposed electric zone was not so extensive but that direct-current promised reasonable power-distribution efficiency; moreover, the time available gave no opportunity for experimentation.

The New Haven, which planned to use the Grand Central Terminal, of course had to electrify also. But having more time and with a view to ultimate electric operation to Boston the engineers of this road were attracted by the high transmission efficiency of the single-phase and adopted it.

Then began the merry debates as to the wisdom of the New Haven's choice, especially in view of the necessity for developing equipment that would operate on both kinds of current. An announcement that the subject would be discussed always brought out a capacity house—and would do so even today.

The discussion was based on 600-volt direct-current as compared with 6,000- to 15,000-volt alternating-current. As 600 volts is an uneconomical pressure for distribution, single phase, by comparison, was very attractive from the power standpoint, although the possible effects upon telephone and telegraph circuits were considered with some apprehension. This apprehension was well founded, but methods were in due course devised greatly to mitigate the inductive interferences. In the meantime direct-current voltages higher than 600 were being tried and in due course, in 1912 and 1913, the Butte, Anaconda & Pacific was electrified successfully at 2,400 volts. This led to the application of 3,000 volts on the Chicago, Milwaukee & St. Paul, which has since been the talk of the world in heavy traction.

The New Haven gradually extended its single phase and the Norfolk & Western put into operation a single-phase three-phase scheme, the single phase from the overhead being changed to three phase on the locomotives by means of a phase converter. This plan permitted the economical power distribution of the one with the mechanical-power-producing possibilities of the other. The Pennsylvania Railroad is today experimenting with this type of electric locomotive for possible use on the heavy grades in the Allegheny Mountains. And straight single phase has been very greatly perfected in the past sixteen years.

This long introduction leads up to a consideration of the relative status of direct and alternating-current heavy traction today. Obviously it is entirely different from what it was fifteen years ago. The argument that the single phase alone permits the use of an overhead contact system no longer holds. The transmission efficiency of high-voltage direct-current is good enough for practical purposes. And the success of automatic control of even rotating apparatus eliminates another "talking point" for single phase.

From the power standpoint single phase has been a serious problem due to the unbalanced load which it imposes upon the three-phase generators of the power plant. To permit economical operation of the latter the use of rotating "phase balancers" has been introduced. Furthermore, the power supply of this and other countries is tending toward a 50-cycle or a 60-cycle frequency. As single-phase equipment must be designed for a lower frequency, its use will involve rotating apparatus at substations in the form of frequency changers if power is drawn from a general power source. These facts will militate against widespread use of single phase. And last but not least the freedom from inductive interference is a great asset to the direct-current.

From the standpoint of over-all cost, which after all will be the ultimate determining factor as to system, there are undoubtedly some roads that are still best fitted for single phase. Its field would appear to include principally long lines with light traffic. The single-phase three-phase is, of course, best adapted to the forcing of track to its utmost capacity. The general trend, however, is distinctly toward direct-current. To be sure Sweden and Switzerland are committed to a single-phase, and Italy to a three-phase program, but there are some signs of weakening in the alternating-current countries. France appears to have swung over within the past year, while England has come out in favor of 1,500-volt direct-current. The success of the Milwaukee electrification, even with the existing dearth of operating data regarding it, has had great weight with the foreign railway engineers and managers. And the fear of inductive interference effects from single phase is a highly potent influence in this connection.

Concrete Bricks Made Without Forms on Commercial Basis

Horizontal Knife Cuts from Concrete Column Slice Which Vertical Knives Divide Into Standard Size—100,000 Bricks Per Day Plant Capacity

CONCRETE brick, made without forms, is being produced commercially in Brooklyn, N. Y., by the Brooklyn Crozite Brick Corporation. The company's plant, which has been in operation about three months, has a capacity with its four brick machines of 100,000 bricks per day of eight hours.

In general design the brick machine is somewhat similar to a bulldozer, all parts being of substantial and rigid construction. Briefly, the essential parts of the machine are as follows: An 8-ft. vertical column above the machine and leading from the mixer, whose cross-section is the width of ten standard-sized bricks and the length of one brick; a forming head upon which the column rests; a table or support carrying the pallets and which moves up and down so as to bring the pallets in contact with the bottom of the forming head, and again lowers them away from the forming head after the brick has been cut; a horizontal knife, ½ in. thick, arranged to pass between the bottom of the column and the top of the forming head, thus cutting off a section of the concrete mass from the bottom of the column and retaining it within the forming head; nine vertical knives, each ½ in. thick, attached to the horizontal knife and arranged to pass through the forming head, thus dividing the concrete previously cut off by the horizontal knife into ten brick; the mechanical means for feeding empty pallets to the pallet table, and mechanical means for removing the pallets with their loads of brick after the forming of the bricks in the machine has been completed.

Considerable experimentation was necessary before it was found possible to produce a concrete brick without forms, using the wet-mix method. A wide variety of aggregate was used as well as cement from various mills. Variation naturally occurred in the strength of test pieces made even with the same aggregate and cement from the same mill, but by varying, not more than one and one-half per cent, the amount of water used, practically equal results were secured. In the plant at Brooklyn the water content in the mixture is rarely varied more than one-half of one per cent. Such a variation depends upon the greater or less amount of fine material in the ⅜-in. screened aggregate. The aggregate is closely watched to determine when a change in water content is needed.

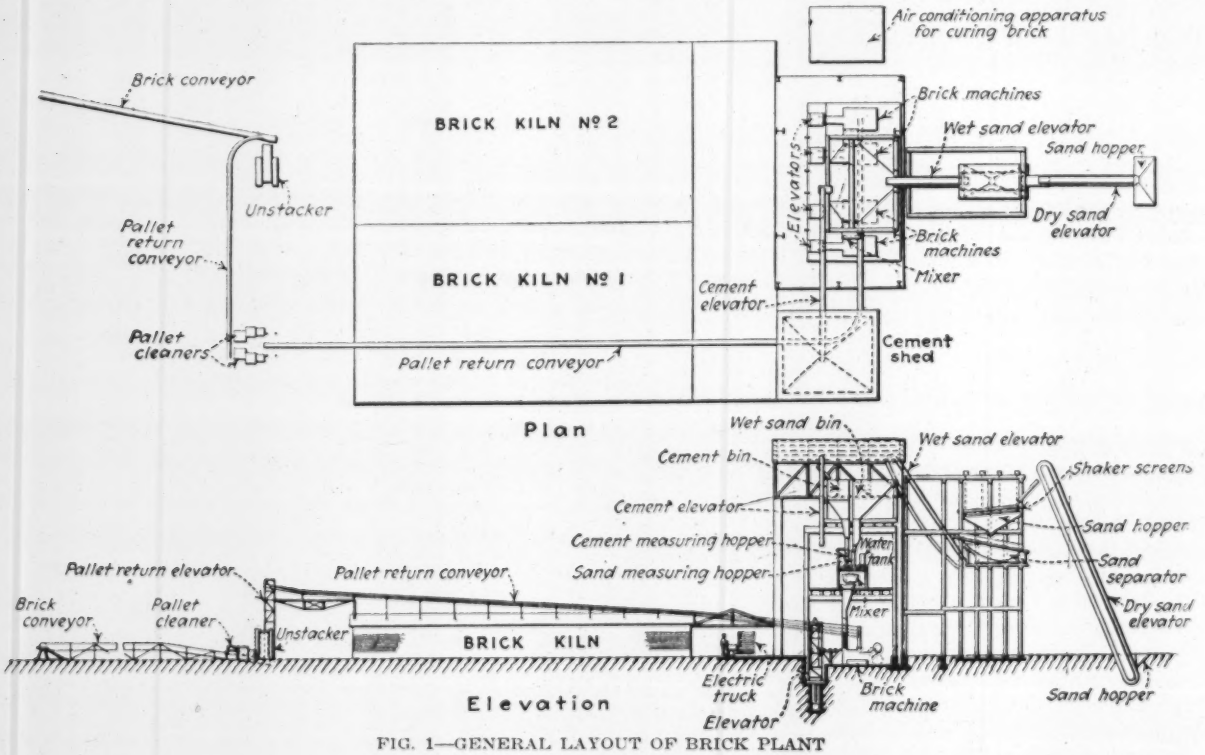


FIG. 1—GENERAL LAYOUT OF BRICK PLANT

The densification and unwatering of the concrete is accomplished in the column above the brick machine through the continual falling of newly mixed concrete in the column, by the weight of concrete within the column and by the sliding pressure exerted upon the mass cut from the bottom of the column by both the horizontal and vertical knives. As each successive layer of material is cut from the bottom of the column the horizontal knife is withdrawn and the mass in the column drops vertically a distance equal to the height of the forming head. This action also has the effect of greatly densifying the concrete, some of the excess water at the same time being expelled.

With the forward and reverse motions of the cutting and forming knives additional pressure is exerted upon

the mass in the forming head, increasing the densification, as the vertical knives cut the concrete slice into ten pieces, compressing that slice 1½ in. The cutting also tends to draw some of the finer aggregate and cement particles to the surface of the brick, in a manner similar to that effected through the use of trowel or float in the usual hand-finishing of concrete. This action gives the finished brick a stippled surface.

As a result of the action of the knives and the head of concrete in the column, the finished brick, though saturated with water and unset, is left upon the pallet in such a dense condition as to stand alone. This feature overcomes the principal difficulties which have been previously encountered in attempts to use wet-mix concrete for the manufacture of brick, block, tile, and other materials on a commercial scale.

The aim of the manufacturer is to produce for local markets building materials which satisfy the specifications for approved masonry, contained in building codes of those cities in which the manufacturing plants are located. Though the Brooklyn plant is manufacturing at the present time a cement-sand brick, the new brick, known as "crozite," may therefore contain different material such as—besides cement and water—sand, crushed rock, screenings, granulated slag, cinders or other fine materials suitable for making concrete and which will pass through a ⅜-in. screen. Three factors which, therefore, determine the sort of brick to be produced in any particular section are: (1) availability of sand or other fine aggregate; (2) city specifications covering approved masonry; (3) the market to be served.

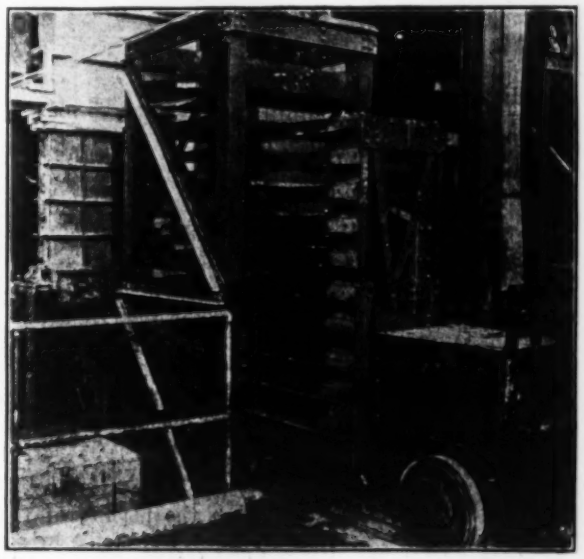


FIG. 3—BRICK MACHINE, ELEVATOR ONTO WHICH UNSET BRICKS ARE STACKED AND TIER LIFT TRUCK WHICH TAKES THEM TO CURING SHEDS

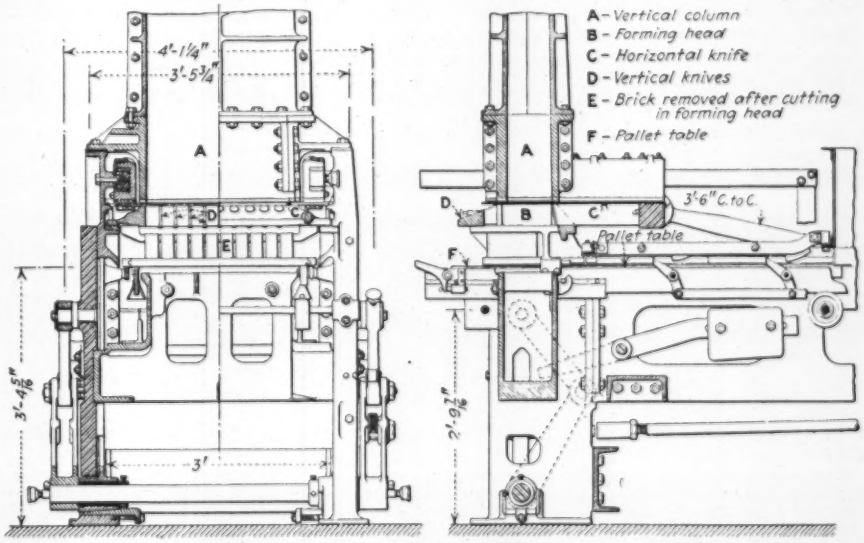


FIG. 2—DETAILS OF BRICK MACHINE, SHOWING ESSENTIAL PARTS

By carrying on a series of tests of different mixes and materials, it has been found possible to meet various building specifications without much further experimentation. Thus, it is possible for the manufacturers in Brooklyn to meet the New York specifications which demand a brick with a compressive strength of 3,000 lb. per square inch.

The Brooklyn plant is located at the site of a sand pit of good quality and practically inexhaustible supply. One electric shovel handles the sand from the bank to a small temporary storage bin which regulates the flow of sand over a belt conveyor to the screening and washing plant. All material passing a ¾-in. screen is used. Overs are at present being spoiled, though it is the intention of the manufacturer to install a crushing plant so that there will be no waste of aggregate. After being screened and washed, the sand is diverted to one of two bins—one being on either side of the screening and washing plant. While the sand from one bin is being used for the mix, it is also being deposited in the other bin, where it is allowed to drain.

Washed sand from these temporary storage bins is elevated by bucket conveyors to hoppers above each of the two mixers which supply the four brick machines. These hoppers are located at about the third floor level, the mixers being at the second floor level, approximately 15 ft. above the brick machines. Cement is also elevated in the same manner as the sand, from a storage shed and large bin to a hopper above the mixer. Both these hoppers are fitted with cut-off gates so that the mixer operator is able to regulate exactly the amount of sand and cement for any particular mix. Water for the mix runs from a small tank above the mixer. The tank is provided with an overflow pipe and is filled for each mix, water being shut off as soon as the overflow begins. Thus, the amount of cement, sand and water is automatically regulated for any particular mix according to predetermined volumetric ratios.

Mixture of the materials is effected in a batch mixer of 21-cu.ft. capacity, with two sets of paddles operating eccentrically and in opposite directions. The mixer

is cradled to discharge easily into the chute almost directly beneath it. A complete cycle of mixing operations consumes, on the average, four minutes, the actual mix always being given at least one and one-half minutes. The concrete is chuted from one of the two mixers to one of the vertical columns above the brick machines, each mixer serving two machines. Waste from the brick machines and any unset, deformed bricks are deposited in a steel bucket which is elevated from the machine to the mixer, where it discharges its load.

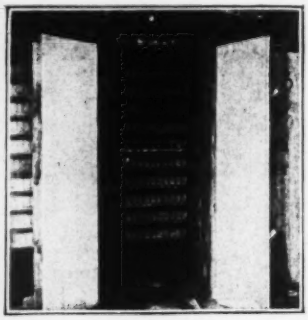


FIG. 4—ONE AISLE IN THE CURING SHEDS

In the complete operation from the placing of the aggregate in the bins over the mixers until the bricks are stacked in the yards or shipped for use, materials including the finished bricks and the pallets are handled entirely mechanically, the arrangement of mechanical devices being such as to reduce to a minimum hand labor required in the process of manufacture.

With each stroke of the knife in the brick machine, the material deposited upon the pallet is divided into ten bricks. Each machine operates at the rate of 4,000 bricks per hour. The racks upon which the pallets with their bricks are deposited, while the setting of the concrete is taking place, are inclosed in a suitable building so as to protect the material from the weather and undue drafts, and so that uniform results may be obtained. Means have been provided for supplying the building containing the racks with moist or humidified air of any desired temperature. The temperature is usually kept around 80 deg. F., and the atmosphere is continuously kept at the dew point. This arrangement has been provided; first, for the purpose of insuring that the concrete material be in a moist condition while setting and hardening; and second, for the purpose of hastening the set of the concrete and thus reducing the time required between the forming of the bricks and their removal from the pallets for use. Uusually, bricks, remain in the curing shed for a period of 48 hr. before being delivered to the storage yard.

Brick machines and the handling devices at the machines are controlled from a central point of the plant by means of compressed air, one operator being in control of four machines. The bricks on pallets are conveyed from the machines to the racks by means of specially constructed storage battery cars which handle pallets aggregating 500 brick to a load. Bricks are removed from the racks after setting by this same type of tier-lift truck.

After leaving the curing sheds the pallets with the bricks upon them are deposited by the tier-lift trucks in a tier-lift elevator. From there they are run on a conveyor through a device which separates the brick from the pallet, cleans the pallets with revolving wire brushes, oils them and elevates them for return to use at the brick machine. The bricks are further conveyed to a stacking bench through belt conveyor and gravity rollers where they are handled by a compressed air handling device onto industrial cars, 930 bricks being stacked on each car.

The surface of the storage yard is covered with a timber grillage. Bricks being moved out into the yard on industrial cars are so stacked that the top layers have elevations and depressions corresponding to this grillage that covers the storage area. A steam driven gantry spans the storage yard, which it serves. It is fitted with a C-grab whose bottom surface is so constructed that it dovetails with the grillage in the storage area and the open spaces left in the top surface of the brick stacks on the industrial cars. This C-grab is slipped under a load of 930 bricks, both to store in the yard and to remove it from the yard to auto trucks for delivery upon order.

As previously noted, materials used in the manufacture of products by the crozier system, due to their wide and general distribution, are such as to permit the location of the manufacturing plant, if desired, near to, or immediately at, the market and center of distribution, thus permitting a very material saving in transportation. The installation of mechanical appliances and labor-saving equipment in the plant has been carried out in unusual detail. The expense of this equipment is largely offset by the fact that the cost of coal, which is a big factor in the production of clay products, is practically elminated in the manufacture of concrete bricks, while labor is reduced to a minimum.

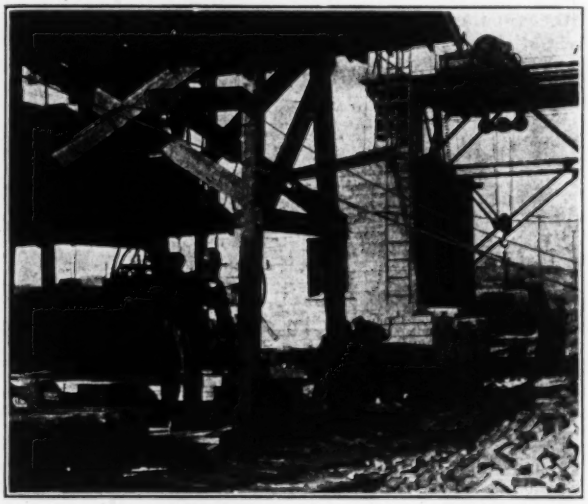


FIG. 5—PNEUMATIC STACKERS, AND C-GRAB OPERATED BY THE GANTRY

Various tests have been made upon crozite products by the testing engineer of the company itself and by representatives of the Robt. W. Hunt & Co., The Lewis Institute, the Pittsburgh Testing Laboratory and the testing laboratory of the civil engineering department of Columbia University. These tests indicate that crozite bricks can be made to meet easily New York specifications, and they also have indicated that the absorption, as compared with clay brick, is quite low, from 4 per cent to 10.81 per cent—dry weight percentage—depending on the mix. This fact tends to make them of a much higher fire resisting power, and less subject to weathering.

The natural color of the product, as in all concrete, depends on the aggregate used and varies somewhat with different aggregate. For use as face brick a large variety of different color effects may be obtained by adding to the aggregate in the mixer various mineral colors.

FIG. 6—GENERAL VIEW OF STORAGE YARD

The color may be varied at will to meet the requirements of the builder and architect and at very small additional cost of manufacture. In addition to this variation of color a process has been worked out for applying facings of various materials to the bricks as they are removed from the brick machine and while the concrete is still west, thus insuring a complete and proper bond between the body of the brick and the facing layer.

The manufacturers of crozite have found that they can very well meet with their cement-sand brick as manufactured in Brooklyn, the present price quotations on clay products of a similar nature.

Better Freight Handling Methods by Mechanical Equipment

Important Economies Effected by Adapting Existing Terminal Facilities to More Efficient Methods of Operation

By O. W. Stiles
Manager, Industrial Transportation Department, Lakewood Engineering Co., Cleveland

AN IMPORTANT lesson of the war, and one still more forcibly brought to our attention by the recent congestion on the railroads, is the need of better terminal facilities. Here, in the terminals, transportation charges, as an element in the cost of production, can be reduced by the installation of proper mechanical handling equipment in present plants with economies that are astonishing. The recent congestion of the terminals proved conclusively that the freight traffic of the country is so dependent upon terminal facilities that congestion at any one point affects the entire system. But how is the difficulty to be remedied? Radical changes in our terminals are not practicable and for this reason the average terminal must be subjected to evolutionary changes.

Our railroads are recognized as the best equipped in the world, but they are still using stations built fifty years ago and the methods of handling freight are in keeping with the stations. New freight stations involving huge investments would be no guarantee of any great reduction in terminal costs, which are largely in proportion to the number of interchange switching combinations. While freight-station labor cost is relatively a small item compared to the total terminal expenses, mechanical handling equipment, where installed in present terminals and freight stations, has shown remarkable economies.

A study will determine if mechanical equipment can profitably meet the conditions and requirements of each case. However, the subject necessitates a careful analysis of the movements of freight: First, to determine whether the work can be done more profitably by mechanical methods than by hand; second, the amount of saving possible; third, where this saving can be effected; fourth, the amount of investment justified by the saving; fifth, the best type or combination of types of equipment and whether such equipment will fit in with plans for future development.

Types of Equipment.—Mechanical handling equipment may be divided into three general classes: Portable, semi-portable, and stationary. The portable consists of such equipment as sectional power conveyors, gravity carriers and chutes, tiering machines, portable cranes, hoists, loaders and unloaders, lift trucks, platform trucks, and tractors and trailers. The semi-portable class includes most track devices, such as overhead traveling cranes, half-, full-arch and portal cranes, and industrial railroads with various types of cars. The stationary class includes fixed cranes, derricks, hoists and winches, overhead monorail and telpher systems, gravity chutes, built-in conveyors, elevators, etc. All of these types have their individual use, or may be combined or dove-tailed to effect a complete cycle of operation. The big problem is the prompt movement of freight to permit new freight to take its place and utilize the equipment to full capacity. This necessitates visualizing the terminal as a whole and working out a plan whereby freight proceeds from source to destination, in the shortest possible time, with a minimum of effort, and without conflict with other freight.

TRACTOR-TRAILER METHOD REDUCED HANDLING COSTS 45 PER CENT

A complete and efficient mechanical freight handling system cannot be designed by the average engineer. The success of a system depends upon many factors, and requires specialized knowledge, creative vision, and a knowledge of mechanical and elec-

TRUCK DELIVERS FREIGHT TO POINT OF UNLOADING

trical engineering, as well as practical experience. With the application of such knowledge and experience, the efficiency of a number of terminals and freight houses has been much increased, reducing the cost of operation from 25 per cent to 75 per cent, releasing a large number of men for more productive work, and retiring the investment in from six to eighteen months.

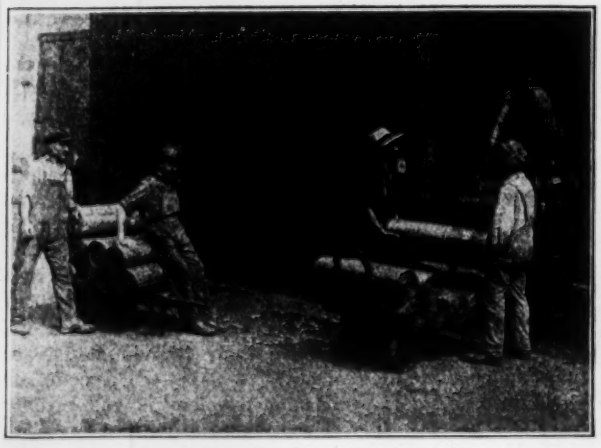
Economy of Tractors.—Frequently the installation of one type of equipment alone will accomplish striking economies. At one large, double-deck terminal freight house on a Middle Western road, an analysis of operating conditions showed that during one month in 1917 eighty men handled a total of 6,798 revenue tons of l.c.l. freight through the house, or approximately 85.3 tons per man, with hand trucks, at a cost of 99.6c. per ton, including supervision. The study also indicated that the same tonnage could be handled with electric storage battery tractors, trailers and hand trucks, using forty-eight men, at a cost of 72c. per ton, including supervision.

A suggested plan was approved and equipment purchased and installed. A check for the year 1919 showed 71.8 men handled 13,578 revenue tons at a cost of 74.2c per ton. This included all increases in wages granted up to Jan. 1, 1920. Compared with the 1917 operation with eight less men, 6,780 tons more freight were handled monthly, at a decreased cost of 25.4c. per ton, or 189 tons per month per man in 1919, against 85.3 tons per month per man in 1917. In March, 1920, another check showed 67.5 men handled 17,025 revenue tons at a cost of 79.9c. per ton, an output of 225 tons per man per month. With 12.2 men less in 1920 than in 1917, almost three times as many revenue tons were handled, the cost still remained 20c. per ton less, and with 300 per cent greater output per man per month than in 1917.

The Port of Charleston, South Carolina, is utilizing the Army Supply Base as a municipal terminal, and with the use of electric storage battery tractors and trailers has reduced the cost per ton of handling miscellaneous freight from shipside into warehouse or cars over 50 per cent, greatly reducing the number of men required, and permitting quick turn-around of vessels. A careful record of maintenance, including interest, depreciation, repairs and current for charging batteries, indicated an average cost of 33c. per hour per tractor.

At one of the small terminals of a central Western road, the use of four tractors and two hundred trailers reduced the labor force from sixty to ten men, and the cost of freight handled, per ton, from 64c. to 34c.

These tractors have been in constant use for from five to seven years. At this terminal, the freight house facilities, previous to the introduction of mechanical equipment, were inadequate to handle the volume of freight with hand trucks. The use of mechanical equipment made possible a great increase in capacity on account of lessened congestion. This increase in freight handling capacity was attained without any addition to, or enlarging of the existing freight house or platform.



TIER-LIFT TRACTOR-TRUCK CUTS COST AND SPEEDS UP LOADING INTO BOX CARS

A recent study of an important terminal at one of the Gulf ports indicated that by simply installing tractors, trailers and lift trucks, a saving could be made of approximately sixty thousand dollars per year; the cost per ton of freight handled could be reduced from 61c. to 46c.; 65 men released for other work and the investment retired in a little over one year's time. Another study of a small inland freight house on the same road indicated an approximate saving of twenty thousand dollars per year, a reduction in cost of freight handled of 12c. per ton, release of twenty-two men, and retirement of the investment in less than one year. An analysis of a large transfer station on an Eastern road indicated a saving of $82,000 per year, a reduction in

cost of 30c. per ton of freight handled, release of thirty men for productive work, and retirement of the investment in six months. These cases are cited merely to indicate the savings possible by the installation of but one type of equipment.

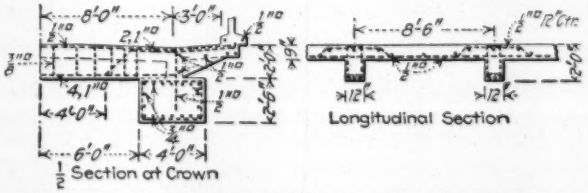
The motorizing of the Cincinnati Terminal resulted in speeding up the dispatch of freight; saved two handlings; decreased damage to freight in loading and unloading 50 per cent, and saved several hundred thousand dollars per year.

It is at present costing approximately $6 per ton, including cartage, to deliver freight from the outer classification yard to point of delivery in New York. Normally, fifty thousand tons of freight are moved daily, an item of $300,000 per day. With the same methods and type of equipment as installed in Cincinnati, the total cost would not exceed $3 per ton. Assuming the same daily tonnage, this indicates an annual saving of $45,000,000 per year.

The superiority of machinery over present methods will lead to its general adoption, resulting in time saved, important economies and terminals in keeping with an efficient transportation system.

Sidewalk Separation on Concrete Bridge

IN THE new Millwood bridge recently completed by the city of Spokane across the Spokane River a special detail of roadway and sidewalk separation has been adopted. This detail is shown in the accompanying sketch. The bridge is in a country district where there is little pedestrian travel. The prospects for the future, however, were thought to be sufficient to warrant the



SIDEWALK AND ROADWAY OF BRIDGE CONTINUOUS WITH BREAK OF GRADE AS SEPARATION

separation of the slope of the outside 3 ft. of the roadway so as to provide a place for pedestrians and also to confine so far as possible the vehicle traffic to the middle 15 ft. This arrangement consisted in crowning the roadway for this 15 ft. and breaking the grade over the center of the arch rib, from which point the sidewalk section arises on a slope to the balustrade. The middle slab and the cantilever slabs are each 9 in. thick and carry an asphalt surface continuous from balustrade to balustrade. It is hoped that the break in the grade will serve to keep vehicles away from the sidewalk, although in case of necessity the absence of a curb will permit them to run there for passing another car or wagon coming in the opposite direction. The work was done under the direction of A. D. Butler, city engineer, with B. J. Garnett as bridge engineer.

Trent Activated Sludge Plant, Turlock, Cal.

A Trent activated-sludge plant for treating the sewage of Turlock, Cal., is being built and is expected to be in use by Feb. 15. At first it will handle 500,000 gal. per day, but it is designed for an ultimate capacity of 1,000,000 gal. It is similar to the test plant at Pasadena, Cal.

Trend of Highway Development —A Survey

THIS IS THE TWELFTH of a series of staff articles on the highway situation. It deals with the rapid strides made in Delaware in the construction of a hard-surface highway system, of refinements in specifications for concrete roads, of surveys made upon concrete slabs, and other studies which have in mind a development of the best obtainable design for concrete roads.

This is the concluding article of the series.

Delaware's Practice

DELAWARE stands alone in highway practice. Committed by law to the construction only of modern type surfaces—a program that has developed into an almost exclusive use of concrete—the state's highway engineers are studying causes for concrete road failures and are focusing their attention upon refinements in design, construction methods and specifications in order that the highest type of concrete slab may be secured. Though various other details make the position of Delaware unique and must be discussed in connection with Delaware practice, the state's progress in concrete-road construction is the outstanding feature.

Highway construction, financed by state funds and superintended by state engineers, is new in Delaware. The state highway commission built its first roads in 1918. However, in 1918, 1919, and 1920 it completed 86 miles of concrete, 6.3 miles of brick, and 10 miles of bituminous macadam roads, of a total of 154 miles contracted for, of which 124 miles are of concrete. Had the construction season of 1920 been a favorable one Delaware would have practically completed her trunk line system.

Concrete Prevailing Type

There are, apparently, at least two good reasons why Delaware is committed to the construction of modern-type surfaces. Delaware is a rural state, about 60 per cent of its population living outside of Wilmington, the seat of the du Pont industrial interests, in towns of less than 5,000 population, or in strictly rural communities. Inasmuch as the community is largely agricultural, has limited rail transportation, and is within easy access by motor truck of such market centers as Wilmington, Baltimore, Washington and Philadelphia, a hard-surface type was deemed expedient to care for expected commercial truck traffic. In the construction of the du Pont Highway, built with private capital, a precedent for durable types had been established.

In choosing concrete for almost all state work several factors entered. First, Delaware has little local commercial stone, depending upon foreign stone for almost all state highway construction. The average materials haul is 100 miles. Therefore, even a waterbound macadam road is, in Delaware, an expensive type. When construction first started on the Delaware system alternate bids were called for. Brick, concrete, sheet asphalt, penetration macadam, and bituminous macadam were the most popular types proposed. In the submission of bids it was discovered that, partly because of the long materials haul, there was little to choose between the various types. Inasmuch as concrete was considered highly from the point of view of durability it was adopted as the prevailing type, even though expensive.

Having accepted concrete as a prevailing type practically the entire personnel of the highway department began the development of the most durable design. The smallness of the highway organization has induced a noticeable co-operative effort. The bridge, construction, design, testing and maintenance divisions, whose chiefs and immediate subordinates are in almost daily informal conference, are pretty well informed as to the studies and investigations carried on and the results obtained by each other. The result of the co-operative effort is marked.

The size of the highway department has also allowed personal inspection by a representative of headquarters of every highway project under construction. Practically every job in the state can be reached by automobile from the chief engineer's office within two hours. The result of this personal observation of construction methods is seen in the refinement of specifications. For instance, for each 1,000 ft. of uncured concrete the contractor is now required to keep at least one man whose entire time is taken up in watering the concrete during its 14-day curing period. If concrete is hand-finished the specifications require that three men be kept ahead of the templet, leveling, tamping, etc. Another specification is that the screed must be a heavy channel iron with at least an 8-in. face. The usual screed used weighs approximately 450 lb. and can, with practice, easily be operated by two men. All these refinements in the specifications only go to show that the engineer is endeavoring to make the specifications as definite as possible, eliminating all the contractor's risks except those which are basic.

Various Practices

Another variation from the usual specifications is that which demands the use of 10 per cent by volume of hydrated lime in all concrete mixtures. Experience in the use of hydrated lime has led the Delaware engineers to conclude that not only can the workability of the mixture be increased, but that the strength of the concrete is increased as well. Experiments that have been carried on indicate the usual results—variation in strength according to aggregate and also the amount of lime used, results with tho different aggregates always being erratic. It is believed, however, that, after experiments in the use of lime have been carried further, local sands, not now usable, may be utilized in state highway work.

With the results that have been achieved in Delaware neither reinforcement of slabs nor the use of expansion joints is considered necessary. Expansion joints were used in some of the earlier pieces of construction, though now they are entirely omitted. Now, at the end of each day's run, ⅝-in. round iron rods, each 4 ft. long, are imbedded in the green concrete and allowed to project so that 2 ft. of the rod will extend into the newer slab. The rods are wrapped in tar paper or some similar material so that they will slide after the concrete has set. Before each day's run the inspectors test these rods to see that they are loose. It is believed that these rods, when placed so as not to form a rigid connection between slabs, not only prevent the slabs from rising when temperature variations are great and tend to cause slabs to buckle, but also offer resistance to truck impact.

The highway department maintains a crack survey which has been termed the "post-mortem" sheet. Upon sheets of standard size are placed the alignment and profile of each newly constructed road. Descriptions and proportions of materials used, the type of mixer, weather conditions, temperature variations during construction, and similar details are noted also on the sheets. As cracks occur the point of cracking is noted on the sheet and its station is indicated. The history of each crack is followed from time to time and the engineers have in many instances determined to their satisfaction causes of the cracking.

Delaware has adhered to a 1:2:4 mix in all its concrete road work. Results secured so far have been so satisfactory that a change to a richer mixture has not yet been deemed necessary. With that mix it is estimated that a saving of $1.50 per cu.yd. is effected over a 1:2:3 mixture. The thickness of slabs, when a 14-ft. roadway width was being used, was 5 in. at the sides and 7 in. in the center. With 16 and 18 ft. now as standard widths, the thickness has been increased to 6 in. at the sides and 8 in. in the center.

Though among the youngest of the highway organizations Delaware has conceived what are considered broad principles upon which a modern highway system should be constructed. For instance, main trunk lines pass outside centers of population wherever it is possible to make them do so. Thus through traffic never interferes with local traffic in congested town streets. Straight alignment, flat curves and low gradients and wide rights of way—never less than 60 ft.—are other principles to which the department adheres. As the highest point in the two southern counties of the state is 65 ft. above sea level, and as it is not necessary to follow section lines in new construction, these principles can be adhered to with regularity.

Boulevard Corporation Roads

Prior to 1917, when the Delaware General Assembly enacted a law establishing a state highway department, road construction was confined to that undertaken by the three counties of the state, and to those constructed through private means. During the 1911 session of the assembly, there was passed a law known as the boulevard corporation act, the two main features of the act being the authorization of corporations composed of private citizens to construct a state road, and provision that after the road was constructed, or any section of it exceeding 10 miles, it should be conveyed to the state free of cost, for the state to maintain.

Pursuant to this act the du Pont Boulevard Corporation was formed, them ain incorporator being General T. Coleman du Pont. Various surveys were made in all the counties with a view to finding the best place for making a beginning of a north and south state trunk line. From the creation of that corporation until the state began constructing roads work was done, intermittently, on a road extending north from the Maryland border toward Dover. When the state highway commission began functioning approximately 28 miles of 14-ft. concrete pavement on this route was completed and had been conveyed to the state for maintenance. That road has been extended until there is practically a hardsurfaced trunk line extending from the north to the south of the state, General du Pont contributing the funds for the construction of this highway up to a cost of $44,000 per mile, the state paying any costs in excess of that figure.

Money for the construction of roads in Delaware by

the state is provided from the receipts of automobile taxes and from the state income tax in excess of $250,000. During the war there was some money available from the state income tax, but since the war the receipts have failed to exceed $250,000. From these receipts the state must set aside $250 per mile for the maintenance of roads already taken over. Expenses of administration of the state highway department are then budgeted and the remaining money is available for construction purposes. During 1917 approximately $84,000 came from the automobile tax fund. In 1918 this increased to $232,000, in 1919 to $286,000 and in 1920 up to Dec. 1, $330,000. In the past this money has been used to finance bond issues, so far $2,100,000 of forty-year sinking fund bonds having been sold and $500,000 more in bonds advertised. Thus the state is allowed to proceed on a much larger construction scale than were it to use the automobile funds available only from year to year. With these funds the state has reconstructed a portion of the Philadelphia Pike just out of Wilmington, expending more than half a million dollars on approximately six miles; and has built a portion of a second north and south trunk line from Dover and to the west of what is called the du Pont road.

Delaware has undertaken no specific mileage to build in order to get a state highway system. Roads requiring construction are built and as constructed are added to the system, which now includes approximately 300 miles of highway. Highways constructed also by state aid are, when completed, added to the system, though part of the maintenance cost is paid by the county in which the roads are located. Most of these state-aid roads are east and west laterals and often of a bituminous type. The sum of $300,000 per year is available for division among the three counties on state aid work. In order to participate in state aid all three counties have issued bonds. In 1917 Sussex County authorized the issuance of $1,000,000 in bonds, in 1919 Newcastle the issuance of $700,000, and last year Kent authorized a $1,000,000 bond issue.

The geographical character of Delaware makes its trunk line highway system one of north and south routes. Tapping the agricultural districts of the state and making easily available market centers has been the chief business of the State Highway Department. Believing a concrete road to be the best type of modern construction and believing that a better slab may be secured through study and investigation, Delaware's "family" of state highway engineers bid fair not only to popularize the motor truck on the farm but to add much in research upon concrete highway construction.

Garbage Quality Reflects Thrift Tendency

Observations made to determine the tonnage and nature of the refuse collected and delivered to the garbage destructor in San Francisco, according to a report by M. M. O'Shaughnessy, city engineer, show that the city's garbage has decreased from 540 tons a day in 1915 to 380 to 400 tons per day at the present time. This decrease is ascribed to two causes, the increased value of paper, rags, etc., and the consequent activity of junk men, and to the increasing practice of economy in the household. Analyses made of the garbage at various times show the following contents: combustible, 20 to 25 per cent; moisture, 45 to 50 per cent; ashes and incombustible, 25 to 36 per cent; all percentages being by weight.

The Cement Manufacturers Before the Lockwood Committee

AS PREVIOUSLY recorded in this journal, a New York legislative committee has for some months been investigating the building industry of New York City. At the end of December it quizzed a number of eastern cement manufacturers in the endeavor to show that they control closely the distribution of cement and use that control as an element in fixing prices. The questioning was so conducted as to convey the impression that there was a strong case against the manufacturers. In fact, *Engineering News-Record*, in its issue of Jan. 6, p. 46, conveyed the same impression, the report there printed being prepared from a summary of the proceedings. The testimony now being available in full, a conclusion as to what was shown can be drawn.

Such examination leads to the conviction that, so far as this testimony goes, the case must be adjudged, "not proven."

It will be well to understand, first, the character of the proceedings. The investigation consisted solely in the questioning of subpœnaed witnesses by the counsel of the committee. That was all. Testimony was not taken under court rules of evidence. Witnesses were not allowed counsel; consequently there was no cross-examination to clarify the testimony or to show that it meant something different than was disclosed under the direct questioning. Counsel for the committee, Samuel Untermyer, a very sharp inquisitor, in trying to make a case against the witnesses asked only such questions and permitted such statements as would help to build up his case.

"Specific Job" Deliveries

His chief point of attack, in endeavoring to prove control and price fixing, was on the practice on "specific job contracts." These are contracts by which the manufacturer guarantees to supply a dealer at a definite price all the cement required for a specific job which will require shipments beyond a 15-day period. Mr. Untermyer endeavored to show that under these contracts if a dealer received and paid for cement in excess of the job's requirements, he would have to return the excess cement. It was clearly proved, however, that this could not be the case, first, because under the cement manufacturers' practice excess cement is not shipped to jobs, and, second, because on these contracts cement is not paid for when ordered but only upon shipment.

The purpose of the "specific job contract" is to allow a contractor to bid on a job with assurance that the cost of his cement will not increase, even if the job last one or two years. The benefit accrues also to the engineer and the owner, for without the "specific job contract" the former could not estimate with certainty cement costs on jobs, nor could the owner know in advance his probable investment. If under such a contract a dealer could get more cement than was required for the job covered, he would, in case the price went up, be able to get cement for general sale below the market price, thus taking advantage of the practice established for the purpose of stabilizing construction. On the other hand, if the market price should drop and the demand be slack the dealer would refuse to take the excess cement and possibly leave the manufacturer with a large stock which he had been reserving for this and for similarly cancelled options.

To prevent such over-ordering nineteen eastern manu-

facturers are operating the Cement Manufacturers' Protective Association, which distributes to its members a record of all "specific job contracts" that have been closed, and which, on demand of members, sends inspectors to these jobs to determine and report on the quantity of cement needed. In this way, only the amount of cement needed is shipped, the contract allowing cancellation of excess amounts.

Mr. Untermyer tried also to show close control by questions designed to indicate that for general sale, called "warehousing" in the cement trade, a dealer could contract only for the amount of cement that a manufacturer could ship him in 15 days, even though the dealer would pay for all the cement he could get. The testimony of the only manufacturer quizzed on this point did indicate such to be the practice. In fact, though, a dealer can, from some companies at least, contract for cement for warehousing over a period longer than 15 days, *but* the companies will guarantee the price for only 15 days. Moreover, depending on the usual manufacturers' precaution of seeing that all his customers are supplied and of not allowing one or two men to "hog" his output, the dealer can secure as much cement as he wishes. The testimony brought out that information is not exchanged regarding cement sold for warehousing, so that a dealer can buy large supplies simultaneously from several companies.

Statistics exchanged by the companies regarding stocks of clinker and cement on hand and amount of cement shipped were attacked as a means of controlling production. This was admitted by a manufacturer who said that they "assisted in preventing overproduction," but he maintained that the information was necessary for the intelligent direction of his business.

Prices

On the matter of prices, there was sharp questioning in an endeavor to prove collusive price fixing, but this line of examination failed to produce any supporting evidence. It was admitted by manufacturers that prices quoted by competing companies were never apart except for a few days at a time, but this, it was maintained, was normal in the marketing of a standardized product.

Also, there was endeavor to create the impression that the large size of some of the companies enabled them to control the market and that the profits have been large. One of the big companies declared last year a 50-per cent stock dividend on its common stock, and another—a 25 per cent stock dividend, but, against the wishes of the committee's counsel, the president of the first company slipped in the statement that his common stock had not paid a dividend for ten years.

Costs of cement, in relation to the manufacturer's selling price, received some consideration, but the resulting testimony was so confused as to allow no intelligible conclusion to be drawn.

The practice of charging, on direct sales to contractors, 10c. per barrel more than to dealers, to which contractors have so often objected, was barely touched upon, and nothing informative brought out.

The inquiry as a whole may be summarized as follows:

It was unfair in its methods and failed to substantiate what the counsel for the committee endeavored to show—unfair control and price fixing. It did, however, give general publicity to the system of marketing cement, but the newspaper summaries conveyed to the public not what the testimony showed but what the counsel for the committee hoped that it would show.

Precast Slabs vs. Monolithic Concrete for Repairing Paved Roads

MINOR repairs to concrete pavements on the state highway system in California are now made by two methods, one or the other being chosen according to conditions. These are (1) casting new concrete in place, or (2) using one or more precast slabs, 1½ x 3 ft. in size and 6 in. thick. This standardization of practice came after experiment with various methods, including use of the cement gun, making and keeping in stock slabs of various sizes, and divers means of securing a compact foundation beneath the point of repair and of making joint between slab and pavement.

The chief disadvantage of casting a patch in place is that, after repair, traffic must be kept off it for ten days. With the precast slabs, on the other hand, the fundamental disadvantage is the difficulty of getting them set so they will maintain the continuity of the pavement surface under heavy traffic. For small patches, particularly where inconvenience results from diverting traffic around the repair, the precast slabs are preferred. On less traveled roads, and where the area to be patched is of considerable extent, a small mixer is usually taken to the job and the concrete poured in place. Where the latter method can be used, less time is required for preparing the foundation and the edges, highway officials point out. The shape of the patch is purposely left more or less irregular to give a better bond. On the whole, the monolithic patch is often easier to put in, and highway officials consider it cheaper and less likely to give trouble.

The use of precast slabs was begun several years ago; at first an attempt was made to stock sizes from 1 ft. to about 6 ft. long and of various widths. The large slabs were discontinued because of the difficulty of placing them. Getting them into place was slow work and, because of their weight, it was most impossible to bed them in mortar or sand satisfactorily. The larger the slab, highway officials point out, the less the likelihood of an even distribution of stress over its entire base and hence the greater the danger of breaking under traffic.

No limit has been set on the maximum area that can be effectively patched with the smaller slabs. A score or more of the 1½ x 3 ft. slabs are sometimes set with their edges in contact. Either asphalt or grout is used to fill the joints between slab and pavement. With the grout a better bond could be made, but it takes time to set. The danger with the asphalt is that it may heat and, if the foundation becomes uneven, permit the slab to tilt under heavy traffic. The slabs are made with a 1:2:4: mix; heavy wires are imbedded with loops protruding for convenience in handling.

South Carolina's Highway Program

More than $6,500,000 worth of highways are now under construction in South Carolina, according to figures compiled by Charles H. Moorefield, state highway engineer. This work embraces 39 projects, all under way with about one-third of the work completed. In addition to the highways now being constructed approximately $200,000 worth of roads are now being advertised, and bids will be received on these during the next month or two. All but 15 of the 305 miles under construction are top-soil, gravel and clay roads.

Interstate Water Conflicts and Possible Solution

Complete Utilization by Large Projects for Irrigation and Power Depends on Engineering and Legal Co-operation of States Involved—Possibility of Interstate Compacts

By R. I. Meeker
Irrigation Engineer, Denver, Col.

LEGAL and engineering co-operative study of the physical conditions, potential water needs and relation of the various parts of a river basin, recognition of the general low efficiency under which water is applied for irrigation, more thorough investigation of the relation and magnitude of return flow water from irrigation, and appropriate legislative action by agreements or compacts among the states involved are some of the principal factors entering into the effective settlement of interstate water conflicts or determination of water utilization.

Fundamentally two forces have been contending in the development of water supply in large river basins of the semi-arid West; physical conditions and divided authority. States are made up of arbitrary political divisions of river basins, and, since each state controls and administers its water supply, utilization of water for irrigation and power has progressed independently in each state on long river systems. Through co-operative efforts there are a few exceptions.

Physical conditions of river flow and relation of irrigable areas to storage sites are antagonistic to divided authority when complete utilization is attempted. The final control of western rivers requires efficient storage capacity. Reservoir sites for such control must be developed according to physical location or opportunity, which may be in other states hundreds of miles away from the point of water utilization. Conversely, large reservoir sites constructed in a lower state depend largely on the run-off of upper states.

A period in the western United States has been reached where future irrigation and power development must depend largely on water equalization and regulation through the construction of reservoirs. Since river flow is now administered under divided authority, some legal adjustment of state water laws and apportionment of state waters must be reached as a sound basis for future construction and use.

The pressing water needs of the future and the spectre of interstate litigation are commencing to awaken thinkers among engineers, attorneys and state and federal officials to the necessity of studying river basins regardless of state lines, and evolving some economic, legal and equitable interstate plan of development and administration that will permit of the widest use in each state, and yet assure and leave undisturbed the existing vested rights. On several western streams plans are now crystallizing for large storage, irrigation and power projects whose effect upon a river system is so great as to compel study of their relation, both physical and legal, for hundreds of miles. Consequently, complete utilization may rest on interstate study and co-operation.

Especial reference is made to the proposed constructive and comprehensive plan of development of the Colorado River and its tributaries by the League of the Southwest. Roughly, this plan contemplates the pooling of water supply by the seven interested states—Wyoming, Colorado, Utah, New Mexico, Arizona, Nevada and California—through engineering investigation and study and the formation of a program that will provide flood control for the lower river and the widest use for irrigation and power in both the upper and lower portions of the Colorado Basin. Sixteen million acre-feet of water annually and more than 5,000,000 acres of land, of which 2,000,000 acres are now irrigated, are included in the plan. Storage reservoir sites of as much as 25,000,000 acre-ft. capacity are being investigated, and hydro-electric possibilities of 2,000,000 hp. are being discussed. The State of Washington has expended $100,000 in studying the irrigation possibilities of the Columbia River Basin, dependent upon water supplies from Montana, Idaho and Washington, for a project of 1,750,000 acres at an estimated cost of $300,000,000. Contrast these projects with those originating earlier than 1910.

Prior to the passage of the Reclamation Act in 1902, irrigation projects were small and were generally confined within a single state. Today even when private and Federal Reclamation projects do not cross state lines they are nevertheless interstate in character because of the heavy water demand they impose, and the far-reaching effect that demand may have for hundreds of miles up or down a river. Projects of the future involve extensive control by reservoirs, the position and relation of which on a stream will be thoroughly interstate in character.

By reason of its high and extensive mountain system Colorado is the radiating source of four major river systems: the Platte, Arkansas, Rio Grande and Colorado. Wyoming and New Mexico occupy similar positions with reference to interstate waters, being the source of four river basins each.

Colorado's strategic position in water supply, however, has its obligations (as witnessed by interstate water suits), since the four above-mentioned rivers traverse nine states, and one of them impinges on the Republic of Mexico, in all of which irrigation is practiced. Some Colorado interstate problems will, therefore, be touched upon as typical of conditions in the West generally and illustrative of the need of a better solution of interstate water conflicts than litigation.

A review of interstate water litigation discloses that during the past 26 years six interstate suits have been brought against Colorado, or Colorado ditches, on four river systems. Arranged in order of occurrence they are:

COLORADO INTERSTATE WATER SUITS

Stream and State	Date of Suit	Court	Remarks
Arkansas River.... Kansas-Colorado	1901	U. S. Supreme	Insufficient injury shown by Kansas dismissed without prejudice 1907
Laramie River.... Wyoming-Colorado	1910	U. S. Supreme	No decree to date; reargued at request of U. S. Reclamation Service
Republican River	1914	U. S. District	Decided adversely to Colorado.
Nebraska-Colorado	1915	U. S. Circuit	Decided adversely to Colorado.
	1917	U. S. Supreme	Appealed; no decision to date.
Arkansas River.... Kansas-Colorado...	1910	U. S. District	Settled by compromise in 1916.
Arkansas River.... Kansas-Colorado	1916	U. S. District	No decision to date.
South Platte..... Nebraska-Colorado.	1917	U. S. District	No decision to date.

Other conflicts loom on the horizon, of which one is on the La Plata River (a small tributary of the San Juan), between Colorado and New Mexico. Latent conflicts exist on the Rio Grande and North Platte River, and potential or prospective problems on the Colorado and its principal tributaries. Litigation of 18 years' standing has not resulted in a solution of these vexing problems.

Important questions of water conflict have arisen and will continue to arise in the future in other states. Unless legal co-operation between various states is had on interstate rivers, the 17 states where irrigation is essential to successful agriculture will witness much litigation in the future. Continued development of interstate streams is inevitable. A possible solution, or a step in that direction, is one of mutual compacts or treaties between the states involved, based upon a thorough engineering investigation of the physical facts of water and land relationship and economic use supported by legal advice and legislative assistance. Thorough examination and analysis of the underlying physical facts which largely control the use of water in river basins, if properly disseminated among water users, will go a long way toward wiping out popular fallacies, local antagonisms and misunderstandings which surround water rights.

Interstate Water Problems

A brief reference is here made to some specific interstate water problems observed by the writer in his professional practice.

State-Line Ditches — Administrative problems on state-line ditches (canals crossing state lines) are serious because such canals are virtually outlaw canals. A concrete example is that of the Mitchell Canal from the North Platte River which diverts water one-half mile west of the Nebraska-Wyoming line and furnishes water for the irrigation of land in Nebraska. The State of Wyoming has no particular interest in the control of this canal because the water is utilized in Nebraska, and the headgate lies below all headgates in Wyoming. Water officials of Nebraska cannot regulate the headgate because it lies in an adjacent state; hence, this canal diverts water at its own pleasure regardless of prior rights in Nebraska. Many state lines have one or more of these canals. The Republican River interstate water suit was caused by a state line ditch. Two such ditches divert water from the La Plata River in Colorado for use in New Mexico. The two main canals of the North Platte project are of the interstate type.

Interstate Reservoirs—Large reservoirs have been constructed in an upper state to supply lands in a lower state, involving the use of a river channel as a conduit for hundreds of miles. An example of a reservoir in an upper state largely operated for the benefit of lands in the lower state is the Pathfinder reservoir (1,170,000 acre-ft. capacity) on the North Platte River, Wyoming, the water of which is used chiefly in Nebraska, on the North Platte Project, extending as far east as Kearney, a distance of 500 miles. The Jackson Lake reservoir in western Wyoming supplies Idaho lands along the Snake River with stored water.

The utilization of large reservoirs in lower states demanding a satisfactory water supply from an upper state is interstate in character. Such a reservoir in the lower state operating to the detriment of an upper state is the 2,600,000-acre-ft. capacity Elephant Butte reservoir of the Rio Grande Project in New Mexico. In this case canals and reservoirs of any magnitude undertaken later than the initiation of the Rio Grande Project have been denied a right-of-way over government land for the reason that the water supply of the Rio Grande was believed to be insufficient for development of any lands other than those within the Federal Reclamation project. The Pathfinder reservoir also falls in this class for the reason that development above Pathfinder reservoir on the North Platte River in Colorado and Wyoming has also been restricted through denials of rights of way; but co-operative study between the State of Wyoming and the U. S. Reclamation Service will probably adjust this difficulty.

Trans-Mountain Diversions — Withdrawing water from the original drainage basin to an adjacent one, but within the confines of a single state, may have an interstate relation. A concrete example of an intrastate trans-mountain diversion on an interstate stream is the two-mile Laramie-Poudre Tunnel which proposes the diversion of water from the headwaters of the Laramie River in Colorado to the Cache la Poudre River in Colorado. The Laramie River lies in both Colorado and Wyoming, the water originating chiefly in Colorado, and the irrigable lands of the basin lying mostly in Wyoming. It is proposed to take annually 56,000 acre-ft. of the headwater flow away from its own drainage basin to an adjacent one in Colorado. The Laramie-Poudre tunnel project is the origin of the Wyoming-Colorado interstate water suit. The 3-mile Strawberry tunnel diversion of U. S. Reclamation Service in Utah is another example of a trans-mountain diversion taking water from Green River watershed to Great Basin.

Excess Decrees or Filings—Many cases exist of excess decrees or filings in both lower and upper states not now using all water alleged to be appropriated. Such water rights should be officially reduced to meet the physical facts of beneficial use. In some states this will require the adoption of a modern irrigation code.

International Phases—Interstate problems on rivers whose drainage basin lies within two or more states may have an international as well as an interstate angle. Examples are the Rio Grande, the Colorado and Milk Rivers. At present treaty agreements cover these cases.

Origin of Interstate Water Conflict

The origin of interstate water conflicts is traceable chiefly to the following causes:

Physical Conditions—Political boundaries of most western states cross watersheds, seldom coinciding with boundaries of major river basins. Hence, topographic and hydrographic features of river basins seldom correspond with state lines.

State Ownership and Administration—By constitutional provision the waters of some of the states are declared to be *public property* held in trust for appropriation. The administration of the use of the public waters lies in separate states, and since the principal rivers traverse two or more states, river basins have become artificially divided into sections through independent utilization and administration in each state.

Reduced Flow—A reduced direct-flow water supply in the lower state of a river basin, due to increased diversion for additional areas in the upper state, or states, compels indifferent irrigation or abandonment of areas once cultivated, or else imposes the cost of a new or supplemental water supply.

A popular fallacy has grown up among many water users, and some attorneys and engineers, that water priorities on the same stream should be enforced between the states regardless of state lines because of the prevailing common doctrine of priority within the states. This doctrine is plausible on first thought, but is erroneous because enforcement of the supply of any interstate stream according to priorities regardless of the state lines would deprive water users of vested rights (long used and assured by state laws) by changing the relation of every water right, and consequently, the amount of water divertible by each ditch. In some instances inferior water rights would be enriched and in others dependable direct flow rights depleted to flood rights or even worse, and every gradation between would occur. In fact, in many cases such administration would be practically confiscatory of vested rights.

The application of interstate administration according to priority dates of old rights to streams and their tributaries traversing two or more state and affecting several hundred to a thousand ditches scattered through a distance of one hundred to one thousand miles, would disturb the entire use of water in the river basin.

Physical conditions of our main interstate streams are also opposed to the literal enforcement of priorities of state lines. In the arid west practically all of the main interstate streams originate in high mountainous territory, pass through plain or plateau areas, and in the lower third of the basin the channel becomes wide, sandy stretches, wasteful of large volumes of water during the hot summer months by evaporation and lateral percolation. A few old water rights usually exist along the wide, sandy stretches at the lower ends of rivers, such as the Arkansas, South Platte, North Platte and Rio Grande. Operation of main interstate streams, according to priority regardless of state lines is uneconomic of water, because during the hot summer months large volumes of water are lost by evaporation. In order to deliver comparatively small volumes of direct-flow water for irrigation on the lower end of such rivers to relatively small areas, large volumes of water are, and would be, required to satisfy channel losses. Supplemental reservoir equalization on the lower river and for the lower river appears to be essential in such cases, for in the future it would not be economy to permit large volumes of water to go to waste on the lower river to satisfy a very small area when land values in the upper areas invite utilization. Interstate enforcement of old water rights would place the burden of reservoir development almost entirely on the upper state through a demand of heavy volumes of direct-flow for the lower area. Complete utilization of a river requires extensive reservoir equalization on the lower river as well as on the headwaters area. F. H. Newell has advanced a doctrine of economic use to supplement the older doctrine of beneficial use in irrigation.

Replacement Storage

On most interstate streams where conflicts have arisen there are still unused flood- or winter-flow waters available for storage, and suitable storage sites occur. A constructive step, then, in an interstate settlement would be for the state involved to construct reservoirs jointly with which to minimize the conflict, leave undisturbed the vested rights in the upper and lower states, and apportion any surplus water according to the needs of the various lands within the drainage basin. This would give stability to future development. If interstate enforcement of old priorities is not practicable, then what method of administration will least disturb the present vested rights, permit of additional development and wipe out conflicts extant or likely to arise?

A rational plan of development would be for the various states involved on any particular stream system to organize a joint engineering commission to study the relation of irrigated and irrigable lands, water supply, reservoir equalization, consumption of water, return flow, interstate conflicts and related matters, the findings to be a comprehensive plan for utilization to fit physical facts, and to form the basis of legal interstate water compacts or agreements, as previously indicated. Such a plan has practically been outlined in the League of the Southwest for the development of the Colorado River in seven southwestern states. Joint investigations and studies of water supply, land and water rights, have already been made by the State of Wyoming and the Reclamation Service on the Green River in Wyoming, and the North Platte River in Wyoming and Nebraska. Similar co-operative administration is being practiced on Snake River in Wyoming and Idaho. These joint efforts have resulted in much good and are clarifying the issues, though no binding agreements have been made.

Return Flow and Re-use

A review of irrigation history discloses profound changes in stream-flow, one of which is "seepage" or return water from irrigation. It is well established that canal and lateral losses are heavy on most irrigation projects, ranging from 15 to 50 per cent of the headgate diversion. Additional heavy losses on the irrigated fields occur from evaporation and deep percolation, so that the plant may receive, and actually consume, only from one-fourth to one-third of the water originally diverted. A large percentage of the total losses above cited returns eventually to the stream channel in the form of seepage water, and is re-diverted and re-applied in some instances many times.

The magnitude of return flow or seepage waters is not generally known for three reasons: (1) Several years are usually required to build up the water table, or underground soil reservoir, to equilibrium. This consumes large volumes of water from deep percolation since 1 cu.ft. of soil can absorb one-fourth to one-third of its volume of water. (2) Return waters from irrigation are largely non-visible and where they do appear as small surface streams they become commingled with ditch or river water, and their identity lost. (3) Re-diversion and re-use on tributaries or along the main stream prevent cumulative effect. Special hydrographic studies are required to segregate such water from surface run-off.

In the South Platte Basin in Colorado the annual mountain run-off averages 1,500,000 acre-ft. (15 years' record). Storage development approximates 1,000,000 acre-ft. total capacity. The area irrigated is, in round figures, 1,000,000 acres. The mean annual outflow of the South Platte River at the lower end of the basin is approximately 275,000 acre-ft. (15 years). In round figures the total consumptive use of original water from the mountainous area is 1,000,000 acre-ft. annually, or about 1.0 acre-ft. per acre per year. The explanation is the large volume of return flow and consequent re-use taken in conjunction with the large amount of storage

water available for application on demand at critical times.

Measured seepage returns in a 150-mile stretch on the lower South Platte River in Colorado approximate 750,000 acre-ft. (1918) annually, a heavy increase over ten years ago. Annual measured return flow along a 150-mile section of the Arkansas River in Colorado approximates 350,000 acre-ft. Along the North Platte River in Nebraska between the Nebraska line and Bridgeport, a distance of 100 miles, the 1918 returns approximated 400,000 acre-ft. From the North Platte Project (Interstate unit) alone the visible return flow measured in drainage ditches in 1918 amounted to 1.5 acre-ft. Heavy return flow waters occur also in the 100,000 acres.

Heavy return flow in the Rio Grande area in Colorado has not developed because of lack of natural drainage. Instead, 50,000 acres of land have been more or less waterlogged and alkalied. Artificial drainage is rapidly remedying this feature, and in 1920 the measured drainage water in the San Luis Valley approximated 70,000 acre-ft. Hervy return flow waters occur also in the Sevier River in Utah.

The above facts are cited to show that return waters from irrigation constitute a large factor in water supply, and in the future must be considered in water supply analyses of river basins. They also show that the widest use of water in a river basin will occur if large areas are irrigated in the upper or middle third, thus permitting the re-use of seepage water both along tributaries and the main stream of the lower areas. In other words, irrigation on the upper areas of a river basin is developing storage regulation without cost for the lower areas by storing in the sub-soil water which is discharged slowly back to the stream channels and improves the late summer and winter flow.

Returning to the subject of possible settlement of interstate water conflicts by state compacts, provision exists in the Constitution of the United States for settlement of difficulties between sovereign states so that the legal foundation, upon which to rear a rational procedure for interstate determination of water rights and possible apportionment of unused waters, is available.

Summarizing

Topographic and hydrographic features, controlling physical factors in water utilization, conflict with control by separate states acting independently because political boundaries do not coincide with drainage basins.

Unless constructive legal measures are adopted to fit physical conditions in utilization of water or major river basins, interstate litigation will ensue or development be retarded.

Replacement storage of flood waters or winter flow now unused can be a means of wiping out some of the present interstate water conflict.

Effective solution of interstate conflicts rests upon a thorough co-operative engineering study of a river basin and its land areas and water supply, and a comprehensive plan of utilization that should be the basis of a legal compact or agreement between the states involved. In addition, some provision should be made for the administration of such agreements.

Any plan for settlement of interstate water problems should not disturb the position and relation of vested rights perfected in the various states under state laws and virtually guaranteed by the respective states.

Return flow waters from irrigation furnish a large part of the water supply in the lower irrigated valleys.

Interstate enforcement of old water priorities does not appear practicable in large river basins. Adjustment of interstate utilization by agreements or compacts is offered as a possible solution. Provision for such treaties exists in the Constitution of the United States.

Local Road Materials Report

FIELD parties investigating deposits of road building materials available for projected improvements in Pennsylvania make their reports on a letter sheet size form as follows:

....., Pa., ... 19...

Engineer of Tests:

My investigation of a deposit of.....
Stone-Sand-Gravel

for use on Route ..... Sec. ..... Appl. ..... Auth. .....
County ..... has been completed and the following data obtained: Owners Name ..... Address ..... Location of Supply ..... Dead haul is ..... Mi.
Borough-Twp-County

to Sta. ..... over ..... with an .....
Improved-dirt-farm road, etc. uphill-

..... grade not exceeding ..... Supply was sampled on.....
downhill per cent date

and sample shipped..... Percentage of deposit represented by
date

sample is ..... Workable area of deposit is .....
with average thickness of ..... feet. Stripping would be
..... ft. of ..... Strata vary from .....
sand-clay-shale-etc.

inches to ..... inches in thickness and are.....
Horizontal-Inclined-Etc.

From inspection give exten of variation in quality of strata
.....
..... If deposit consists of boulders or field stone give (1)
Stone Sizes ..... (2) Uniformity ..... (3). Ap-
Structure-Kind

proximate quantity ..... (4) How found .....
Walls-piles-or-

..... Water supply is.....Mi. from deposit. Distance
scattered

to nearest R.R. Shipping point is ..... Mi. Is material available? ..... If not, state reasons why .....
.....

Show by sketch of plan and section, or otherwise, (1) the part of deposit where sample was taken, (2) Location and depth of test pits, (3) How stripping increases or decreases (4) Location of nearby buildings or other obstructions, (5) any other important details, (Use additional sheet if necessary).

If material requires (1) chuting down hillside, (2) mining, (3) construction of incline, (4) new roadway, (5) improving old roadway, (6) or industrial railroad, give all details. (Use additional sheet if necessary).

Approved.....Signed .....
Title .....Title .....

These reports form the original records of the testing laboratory and are the basis of a brief schedule of locations of acceptable local materials which is furnished the contractor when bids are asked.

Slippage in Small Water Meters

Ordinary ⅝-in. water meters on residence services will average a slippage of unrecorded water amounting to 40 or 45 gal. per day, according to tests made on the Spring Valley Water Co.'s system by George W. Pracy, and reported at the recent annual convention of the California Section, American Waterworks Association. The tests were made by using accurately calibrated meters on mains found by tests to be water tight, and supplying groups of the ⅝-in. services. It was possible to pass through both new and used meters, for ⅝-in. services, as much as 200 gal. per day with little or no registration by very small steady flows such as leaks would cause. In other words, the actual loss equals that which would result from one meter in every four slipping its maximum amount.

Engineering Studies of Reclamation Service Resumed

HYDRAULIC investigations connected with the operation of the irrigation works of the U. S. Reclamation Service, interrupted during the war, have now been resumed. The object of the inquiries is the experimental determination of certain factors and elements regarding which little is known, thus permitting more economical design of future works. Much valuable work along this line has been accomplished in the past and an allotment of $3,000 for 1921 has been provided to continue it. J. L. Savage, designing engineer in the Denver office, has prepared a program of data most urgently needed and of what can be done this year.

The investigations completed so far have been printed in the *Reclamation Record* and these are summarized under 36 titles. On nine of these subjects further study was deemed advisable. The subjects are as follows:

EXPERIMENTS TO BE CONTINUED

Seepage losses from canals.
Value of Kutter's *n* for concrete channels.
Transition losses in open canals.
Flow in chutes and disturbances in stilling basins.
Discharge coefficient for siphon spillways.
Friction coefficient for gate leaves and bronze seats.
Coefficient of discharge for overflow dams.
Discharge coefficient through headgates.
Effect of alkali on concrete.

In addition to the above, 21 other subjects are considered more or less urgent. A summary follows of these questions on which experimental data ultimately should be obtained.

EXPERIMENTAL DATA NEEDED

1. Value of Kutter's *n* in concrete pipes
   (*a*) Monolithic pipe.
   (*b*) Precast pipe.
2. Curve losses in pipes
   (*a*) Wood-stave pipe.
   (*b*) Monolithic concrete pipe.
   (*c*) Precast concrete pipe.
   (*d*) Steel pipe.
3. Losses and recoveries
   (*a*) Flume inlet and outlet structures.
   (*b*) Siphon inlet and outlet structures.
4. Value of Kutter's *n* in concrete flume
   (*a*) Monolithic jointed flume.
   (*b*) Monolithic continuous flume.
   (*c*) Semi-precast flume.
   (*d*) Gunite flume (sides shot against forms, bottom gun finish).
   (*e*) Combination gunite and concrete flume.
   (*f*) Gunite canal lining (all gun finish).
   (*g*) Concrete canal lining, trowel finish.
   (*h*) Concrete canal lining, finished with wood float or other similar finish.
5. Control section weirs
   (*a*) Establish rating curve.
   (*b*) Determine necessary loss through structure.
6. Head gates
   (*a*) Coefficient of discharge for gate opening.
   (*b*) Coefficient of recovery below gate.
7. Pipe turnouts
   (*a*) Coefficient of discharge (gate wide open).
8. Curve losses and disturbances in open channels
   (*a*) Semicircular flume.
   (*b*) Rectangular flume.
   (*c*) Trapezoidal channel.
9. Losses due to piers, bents, abutments, and other obstructions
   (*a*) Bridge piers and abutments.
   (*b*) Check bents and abutments.
   (*d*) Headworks, piers, and abutments.
10. Measuring gate (adjustable Henny Venturi flume)
    (*a*) Establish rating curve.
    (*b*) Determine necessary loss through structure.
11. Flow over dams
    (*a*) Shape of surface curve.
    (*b*) Discharge over various shaped crests under different heads.
    (*c*) Shape of nappe under different heads.
    (*d*) Effect of velocity of approach.
12. Flow in spillway channels parallel to crest
    (*a*) Water surface curve in channel.
    (*b*) Air content.
    (*c*) Necessary effective area for letting air under nappe.
13. Chutes
    (*a*) Value of Kutter's *n*.
    (*b*) Air content.
    (*c*) Effect of curvature.
    (*d*) Angle of entrance to basin.
    (*e*) Effective length of basin.
    (*f*) Effect of baffles in basin.
14. Hydraulic jump
    (*a*) Velocity above and below.
    (*b*) Height of jump.
    (*c*) Cross-section of channel.
    (*d*) Profile of channel for some distance up and downstream.
    (*e*) Details of any local obstruction.
15. Siphon spillways
    (*a*) Losses segregated as far as possible.
    (*b*) Overall coefficient of discharge.
    (*c*) Depth of crest and interval of time to prime.
    (*d*) Position of water surface when seal breaks.
    (*e*) Surface curve at approach of siphon.
    (*f*) Elevation above sea level and barometric pressure at time of experiment (for high siphons).
16. Percolation factors and uplift
    (*a*) Salmon Lake Dam.
    (*b*) Percha Dam.
    (*c*) Grand Valley Dam.
    (*d*) Canal structures.
    (*e*) New dams.
17. Saturation slopes
    (*a*) Salmon Lake Dam.
    (*b*) Deer Flat embankments and other earth dams.
18. Beaching slopes
    (*a*) Gravel embankment.
    (*b*) Earth embankment.
19. Wave heights
    (*a*) Effect of fetch.
    (*b*) Height of splash on different slopes.
20. Outlet works
    (*a*) Losses, segregated as far as possible (gates wide open).
    (*b*) Overall coefficient of discharge.
    (*c*) Capacity curves.
    (*d*) Path of issuing jet from Arrowrock type outlets.
    (*e*) Water cushion.
21. Coefficient of friction
    (*a*) Handwheel and crank pulls for gate hoists under different load conditions.
    (*b*) Gate leaf against sliding surfaces.
    (*c*) Stem in guide.
    (*d*) Radial gate seals.
    (*e*) Concrete flume on earth.

Only a small portion of the above can be done in 1921 because of the limited funds. The choice of subjects for immediate study depended on urgency of the need for the data and project facilities.

EXPERIMENTAL WORK FOR 1920

GRAND VALLEY PROJECT

1. Grand River Dam
   (*a*) Continue recording well readings to determine the hydraulic gradient under dam.
   (*b*) Experiments to determine coefficient of discharge over crest of dam.

HUNTLEY PROJECT

1. Henny Venturi measuring gate
   (*a*) Determine coefficients of discharge.
2. Control section weir
   (*a*) Determine coefficients of discharge and establish rating curve.

KING HILL PROJECT

1. Siphon Spillway, Malade Flume (Gooseneck type)
   (*a*) Determine losses segregated as far as possible.
2. Combination Gunite and Concrete Flume
   (*a*) Determine value of Kutter's *n*.
3. Semiprecast Flume
   (*a*) Determine value of Kutter's *n*.
4. Monolithic Jointed Flume
   (*a*) Determine value of Kutter's *n*.
5. Gunite Flume (sides shot against forms, bottom gun finish)
   (*a*) Determine value of Kutter's *n*.
6. Wasteway from Four-Mile Flume (basin type)
   (*a*) Determine capacity without check.
7. Big Pilgrim Siphon (wood-stave pipe)
   (*a*) Determine inlet, outlet, and curve losses.
8. Little Pilgrim Siphon (monolithic concrete pipe)
   (*a*) Determine inlet, outlet, and curve losses.
9. Flume transitions (modern design)
   (*a*) Determine transition losses.
10. Deer Gulch Siphon (part monolithic concrete pipe and part wood-stave pipe)
    (*a*) Determine inlet, outlet, and curve losses.

RIO GRANDE PROJECT

1. Radial gate hoists (worm-gear type)
   (*a*) Determine pull on handwheel and efficiency.
2. Leasburg Dam
   (*a*) Determine coefficient of discharge over crest.
3. Percha Dam
   (*a*) Determine upward pressure under foundation (hydraulic gradient).
   (*b*) Determine coefficient of discharge over crest.
   (*c*) Investigate standing wave below dam.
   (*d*) Investigate water surface curve above dam.

SHOSHONE PROJECT

1. Metal flume on curve (No. 144 on curve of 63.6-ft. radius)
   (*a*) Investigate curve losses.

SUN RIVER PROJECT

1. Siphon spillway (gooseneck type)
   (*a*) Determine discharge coefficient and sensitiveness in priming.

To Take City Engineers Out of Civil Service

The law committee of the league of Cities of the Third Class in Pennsylvania has decided to try to secure the repeal of state legislation placing city engineers under civil service. An attempt will also be made to secure an act authorizing cities of the third class to establish and regulate building zones.

An Investigation of Perforated-Pipe Filter Underdrains

Limits Determined of Head Required To Obtain Uniformity of Discharge Along Laterals, of Size and Spacing of Laterals and Perforations

By Harry N. Jenks
Special Assistant Engineer, Filtration Division, Sacramento, Cal.

A STUDY of the information available on the design of rapid sand filter underdrains discloses the fact that present-day practice is based largely upon precedent rather than upon experiments made to demonstrate the relative importance of the factors involved. Not only is the underdrain system one of the most expensive structural features of the complete filter unit, but on the correct arrangement and proportioning of the elements comprising it depends the efficiency of application of the wash water used in periodically cleaning the filter. Similarly, the construction of the gravel bed immediately above the underdrains proper has an equally important influence upon the character of the wash. From an examination of the details of design of existing plants in relation to the foregoing considerations, it was noted that wide divergences occur among the values assigned to such factors as the size of perforation, the ratio of area of perforations to filter area, the arrangement of piping, the use of strainer plates and the sizes and depth of gravel. Because of the importance of the subject and the lack of uniformity of practice with regard to the solution of the problems it presents, it was decided by the Filtration Division of Sacramento, Cal., in preparing plans for the eight 4,000,000-gal. daily rapid sand filter units for that city, to determine experimentally the conditions governing the design of a less expensive and at the same time more efficient underdrain system than the commonly accepted types.

On account of its evident advantage in low cost of installation and maintenance, the type of underdrain chosen for these experiments was a modification of the one first developed at Harrisburg, the distinctive feature of which is the use of perforated-pipe laterals spaced at equal intervals along the filter bottom and dividing the filter box into two equal parts. In contrast to former installations of this type, the gravel-bed depth was increased to 18 in., and for the purpose of studying the behavior of the water wash it is to be considered an integral part of the underdrain system itself. The course of the wash water was followed from a point immediately outside the filter box, at the entrance to the lateral, until the water reached the dividing plane between the gravel bed and the bottom layer of sand. The scope of the observations embraced a determination of two principal controlling conditions: (1) The conditions resulting in the optimum hydraulic characteristics in relation to (a) total head required, and (b) uniformity of discharge along the lateral. (2) The conditions governing the uniformity diffusion of the wash water up to the top of an 18-in. bed of graded gravel, the variable factors being (a) the size and spacing of laterals and of the perforations in the laterals, and (b) the rate of wash.

Hydraulic Experiments—The general layout of the apparatus used in making the tests is shown in outline by Fig. 1. The pressure head in the supply pipe varied from 30 to 40 lb. per sq.in.; at the latter pressure it was possible to pass 32 cu.ft. per minute through the meter. From the meter the water continued through a 2-in. pipe into a 16-in. riveted-steel header pipe, 7.5 ft. long, into which ten standard 4-in. wrought-iron pipe sockets had been welded in such positions as to permit laterals to be screwed into the header pipe at spacings of 6, 8, 9 and 12 in., the maximum number of laterals to be used in each case being four. For the purpose

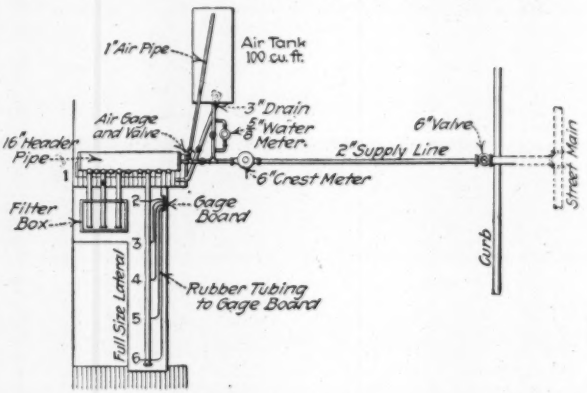


FIG. 1. SACRAMENTO UNDERDRAIN TEST APPARATUS

of obtaining a supply of air under pressure, use was made of an air-tight steel sprinkler-wagon tank, the capacity of which was 100 cu.ft. Suitable connections were made with the water supply, and the air displaced by the incoming water was carried from the tank to the header pipe through an air line.

Measurements of pressure head were made by water columns. A gage board 11 ft. high, suitably painted and graduated in feet and tenths, was erected in a convenient position with reference to the control valves. Six gage glasses extending the length of the board were fixed in place in the following order, from the left:

Gage 1. Head of water in main header pipe. (The table is based upon readings of this gage.)
Gage 2. Head of water at beginning of perforations.
Gage 3. Head of water at ⅓ point along lateral.
Gage 4. Head of water at ⅔ point along lateral.
Gage 5. Head of water at ⅚ point along lateral.
Gage 6. Head of water at end of lateral.

For heads higher than 11 ft. a mercury manometer was used. With this arrangement of gages it was possible to study in detail the hydraulic characteristics of the perforated-pipe lateral as affected by the diameter of lateral, diameter of perforation, spacing of perforations and rate of wash.

The laterals tested were straight, new lengths of standard wrought-iron black pipe. Each pipe had an effective length of 12 ft., and the distance between the first and last perforations was 11 ft. 6 in. Such a lateral is designed to serve a strip of filter bed 12 ft. long (the inside width of a half filter unit) and of a width equal to the spacing of the laterals. Fig. 2 indicates clearly the position of the lateral when under test.

The perforations in the laterals were drilled in a

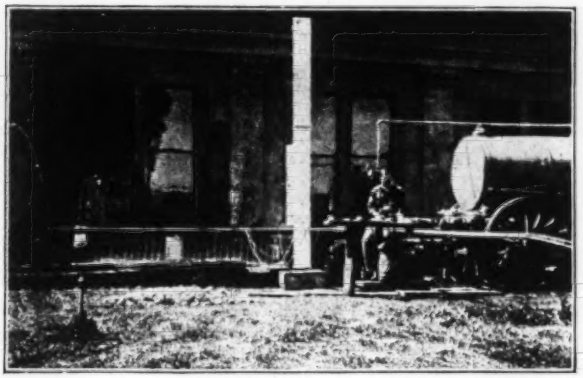


FIG. 2. EQUIPMENT USED FOR TESTING AN UNDERDRAIN LATERAL

Horizontal pipe at left is lateral with jets pointing downward. Vertical gage board in center.

power drill press and all noticeable burrs were subsequently knocked off by scraping the inside of the pipe with an iron bar, and by filing lightly around the inner edge of the holes. Experiments showed that no great degree of refinement is necessary or warranted in drilling the holes to exact dimensions.

The laterals were tested with the perforations pointing vertically downward and discharging freely into the air. In determining the variation in discharge along the lateral, the discharge at the beginning, at the quarter-points, and at the end was caught and measured.

Diffusion Experiments—Having determined from preceding experiments the relationship of diameter of lateral and the diameter and spacing of perforations giving the best hydraulic efficiency, tests were continued to ascertain the diffusion, or effectiveness of distribution, of the wash water throughout the filter bed when applied through the wash-water lateral selected on the basis of hydraulic efficiency alone.

The small filter box containing the gravel bed was made of 2-in. redwood stock, 3 x 2 ft. in plan and 2 ft. deep, all inside measurements. The depth permitted 18 in. of graded gravel to be placed inside, leaving 6 in. of freeboard. The position of the laterals in the filter and the manner in which the gravel bed was built up are indicated in Fig. 3.

In the tests the bed was modified slightly by substituting sand for the top 1½ in. of gravel, in order that, by its movements, the behavior of the wash might be distinctly observed. No different grading or depths of gravel were experimented upon because of the fact that entirely satisfactory results were obtained with the use of the sizes and depth selected.

By placing the 3-in. gravel along the laterals on the filter bottom, an unrestricted waterway was formed directly underneath each pipe, approximately 1 x 2 in. in cross-section and extending the entire length of the lateral. It is believed that the existence of these channels, by equalizing the pressure of the wash water in the plane of the piping system, is an important factor in causing an even distribution of the rising prism of water.

The bottom 8-in. layer, including the 3 in. of gravel, was composed of hand-picked cobbles as nearly round as it was possible to select them from the gravel bank. The other layers comprised the ordinary bank run, screened to the required sizes. Thorough studies were made of the distribution of the wash through the gravel bed under varying conditions of rate of wash, number and spacing of laterals, and size and spacing of perforations, using both air and water. The complete data are too extensive for presentation here; accordingly one experiment only will be described briefly, in which were employed the proportions selected for the final design of the 4,000,000-gal. daily filter units. The design factors were as follows:

	Inches
Diameter of lateral	3
Spacing of laterals	12
Diameter of perforations	⅜
Spacing of perforations	6
Depth of gravel	18

Using both air and water washes, careful observations were made of the behavior of the gravel and thin surface layer of sand under the influence of the rising currents. In the case of the water wash, the diffusion could be very satisfactorily studied by the sand "craters" that appeared wherever the stream lines passed through the sand. Around each crater the sand was kept in constant motion similar to that which takes place on the bottom of a pool fed by springs beneath.

With as low a wash as 6-in. vertical rise per minute, these centers of ebullition of the sand occurred in all parts of the filter; but due to the natural lack of uniformity in resistance to flow at such low velocities the craters were not altogether evenly distributed. It was quite apparent, however, that this was due to the fact that all the water was able to pass upward through these craters and so was not forced to break through over the entire area. That this was the case could easily be shown by making a slight depression

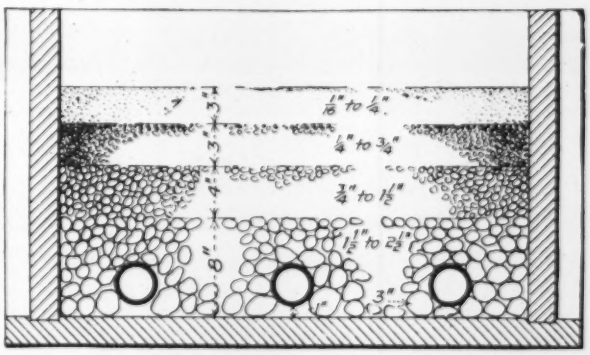


FIG. 3. FILTER BOX SHOWING LATERALS AND GRAVEL

in the sand layer; the resistance at this point being thereby decreased, the water commenced to boil upward at this point, forming a new crater. This was considered sufficient proof that even at low rates of wash the distribution of the wash with the type of underdrain and gravel bed under investigation, is satisfactory. In this connection, also, it is to be expected that the presence of a considerable body of sand and head of water above the gravel bed will tend still further to steady and make more nearly uniform the discharge of the wash water throughout the filter area.

As the rate of wash was increased, the evidences of uniform distribution became more and more marked. At a 24-in. vertical rise per minute and over, the entire filter surface presented a mottled appearance, caused by the formation of craters over every square inch of the surface. These observations on the movement of the sand were supplemented by means of a dye (Uranine A), which was injected into the header pipe

TOTAL HEAD REQUIRED FOR VARIOUS SIZED HOLES AND SPACINGS IN 3-IN. AND 2½-IN. LATERALS FOR FILTER UNDERDRAINS

3-INCH LATERAL

RATE OF WASH Vertical Rise, In. per Min. for Lateral Spacing of				DIAMETER OF PERFORATIONS, INCH — For 2-In. Hole Spacing —			DIAMETER OF PERFORATIONS, INCH — For 4-In. Hole Spacing —					DIAMETER OF PERFORATIONS, INCH — For 6-In. Hole Spacing —				DIAMETER OF PERFORATIONS, INCH — For 8-In. Hole Spacing —		
8 In.	9 In.	10 In.	12 In.	¼	5/16	⅜	¼	5/16	⅜	7/16	½	5/16	⅜	7/16	½	⅜	7/16	½
3	2.7	2.4	2	0.2	0.1	....	0.5	0.3	0.1	....	....	0.4	0.2	0.1	....	....	0.2	0.1
6	5.3	4.8	4	0.3	0.2	0.1	1.0	0.5	0.3	0.2	0.1	0.8	0.5	0.3	0.1	....	0.6	0.4
9	8.0	7.2	6	0.6	0.4	0.2	2.4	0.8	0.5	0.4	0.3	1.9	1.0	0.6	0.3	....	1.0	0.7
12	10.7	9.6	8	1.2	0.6	0.3	4.4	1.7	0.8	0.6	0.5	3.6	1.8	1.0	0.6	....	1.8	1.1
15	13.3	12.0	10	2.0	0.9	0.5	6.8	2.8	1.2	0.8	0.7	5.8	2.8	1.6	0.9	....	2.8	1.7
18	16.0	14.5	12	3.0	1.3	0.7	10.0	3.9	1.9	1.1	0.9	8.4	4.1	2.3	1.4	....	4.0	2.5
21	18.7	17.0	14	4.2	1.7	1.0	14.0	5.3	2.8	1.5	1.1	11.5	5.7	3.2	2.0	....	5.5	3.5
24	21.3	19.0	16	5.6	2.2	1.4	18.0	7.1	3.7	2.1	1.4	15.0	7.6	4.3	2.8	....	7.0	4.7
27	24.0	21.5	18	7.2	3.0	1.9	22.5	9.0	4.8	2.8	2.0	19.0	9.8	5.6	3.7	....	9.0	6.1
30	26.7	24.0	20	8.8	3.7	2.5	27.5	11.3	6.1	3.7	2.7	23.0	12.3	7.8	4.7	....	11.5	7.7
33	29.3	26.5	22	10.6	4.5	3.1	32.5	13.9	7.5	4.6	3.4	28.0	15.1	8.5	5.8	....	14.0	9.5
36	32.0	29.0	24	12.7	5.3	3.7	38.0	16.8	9.0	5.6	4.1	33.5	18.2	10.1	6.9	....	17.0	11.5
39	34.7	31.0	26	14.9	6.2	4.3	....	20.0	10.6	6.6	4.9	....	21.3	11.9	8.1	....	20.0	13.6
42	37.3	33.5	28	17.2	7.2	5.0	....	23.4	12.4	7.7	5.7	....	24.7	13.8	9.4	....	23.0	15.8
45	40.0	36.0	30	19.5	8.4	5.8	....	26.8	14.4	8.8	6.5	....	28.5	15.9	10.8	....	26.2	18.1
Σ V Q	....	....	..	47	58	151	21	36	65	...	81	45	38	16	55	....	11	25
V Q max	....	....	..	14	23	39	6	14	19	...	26	13	13	5	17	....	4	11

2½-INCH LATERAL

3	2.7	2.4	2	....	....	....	0.2	0.1	....	...	...	....	0.2	0.2	0.1	0.3	0.2	0.1
6	5.3	4.8	4	....	....	....	1.0	0.4	....	...	...	....	0.5	0.4	0.3	0.8	0.5	0.3
9	8.0	7.2	6	....	....	....	2.4	1.0	....	...	...	....	1.0	0.7	0.4	1.8	1.0	0.6
12	10.7	9.6	8	....	....	....	4.3	2.0	....	...	...	....	1.9	1.3	0.6	3.2	1.9	1.1
15	13.3	12.0	10	....	....	....	7.1	3.2	....	...	...	....	3.1	2.1	1.1	5.1	3.1	1.9
18	16.0	14.5	12	....	....	....	10.5	4.6	....	...	...	....	4.5	3.0	1.9	7.3	4.6	2.9
21	18.7	17.0	14	....	....	....	14.7	6.2	....	...	...	....	6.1	4.1	2.8	9.9	6.3	4.2
24	21.3	19.0	16	....	....	....	19.0	8.1	....	...	...	....	7.9	5.4	3.8	12.9	8.2	5.4
27	24.0	21.5	18	....	....	....	24.0	10.4	....	...	...	....	10.0	6.9	4.9	17.3	10.6	7.0
30	26.7	24.0	20	....	....	....	30.5	13.2	....	...	...	....	12.0	8.6	6.1	22.0	13.3	8.8
33	29.3	26.5	22	....	....	....	....	16.5	....	...	...	....	14.1	10.5	7.4	27.5	16.3	10.8
36	32.0	29.0	24	....	....	....	....	19.9	....	...	...	....	16.4	12.6	8.7	33.8	19.7	13.0
Σ Q V	....	....	..	....	....	....	....	....	....	...	...	....	....	....	....	....	....	....
V Q max	....	....	..	....	....	....	....	....	....	...	...	....	....	....	....	21	38	....
																7	13	....

and subsequently appeared, evenly distributed above the filter bed.

During the course of the experiments observations were made on the bearing of lateral spacing upon effective distribution. At the outset it was believed that, in deference to current practice, the laterals should be so spaced as to provide, for the particular size and spacing of holes selected, from 0.4 to 0.6 sq.in. of hole area per square foot of filter area (0.28 to 0.41 per cent). The studies clearly demonstrated, however, that a lateral spacing larger than the 6 to 9 in. necessary to meet the above requirement is entirely permissible. The excellent distribution obtained in the experiment under consideration occurred with a lateral spacing of 12 in., providing a ratio of total area of perforations to area of filter equal to 0.0021, or 0.3 sq.in. per square foot.

A convincing proof of the propriety of using a lateral spacing of at least 12 in. was obtained by closing a valve on the middle lateral and using the two outside laterals to serve the entire 6 sq.ft. of filter. The wash water continued to come up as before over the area that should have been supplied by the central lateral.

As it was photographically difficult to record the appearance of the surface of the sand during the progress of a water wash, air was turned on in sufficient amount to cause the surface of the water to be agitated to a degree that should indicate the evenness of distribution of the sand craters in the water wash. Fig. 4 is a photograph of the apparatus operating under these conditions, and shows the completeness with which the wash is broken up and diffused by the deep gravel bed.

The rate of air wash at this time was 48 in. vertical rise per minute, or 4 cu.ft. per square foot of filter area per minute. Extensive tests of the behavior of the air wash were not carried out because of the fact that with the type of wash-water lateral and gravel bed adopted it is expected that the water wash alone will be sufficient to clean the filter sand thoroughly at all times. Should it be necessary at certain times to employ air as an auxiliary wash, it was found that a rate as high as the one mentioned, namely, 48 in., will not disturb the gravel. At this high rate a very even distribution is obtained. Although the size of holes used in this type of lateral is much greater than that ordinarily chosen for use in the air system, it is believed that the stabilizing influence of the resistance offered by the sand layer and the depth of water on the filter in the full-size units, will tend to cause a much more even dispersal of the air at normal rates of wash than it was possible to effect by diffusion through the gravel alone.

Design Data and Conclusions—It is believed that the experiments summarized in the foregoing paragraphs were carried out in sufficient detail and comprehensiveness to justify the acceptance of the results as a reliable guide in judging of the adaptability of the perforated-pipe lateral to the requirements of a satisfactory underdrain system for rapid sand filters. As an integral part of this system, the use of the deep gravel bed, similar to that described, is presupposed.

The table gives the total head required, in feet of water, for various rates of wash, diameters and spacings of perforations and spacings of laterals for 3- and 2½-in. laterals. This is the head necessary to produce the given discharge through the laterals. It is measured from the center line of the pipe and includes the loss of head at entrance (in the case of the laterals tested $h_e = 0.5\ (Vo/2g)$, where Vo is the initial velocity in the lateral), losses in the pipe and head of discharge through the perforations. In calculating the height at which the wash-water storage tank must be placed, to the above head must be added the loss of head through the gravel and sand, the static head on the filter below the top edge of the wash-water troughs and the wash-water pipe line losses between the tank and the entrance to the lateral.

It will be observed that the head required is a direct function of the rate of wash, the spacing of the laterals and the spacing of the perforations; and that it de-

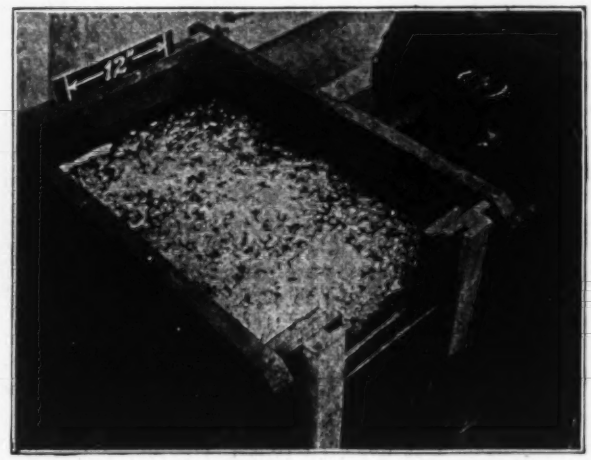


FIG. 4. APPEARANCE OF TEST FILTER UNDERDRAIN WITH 4 FT. VERTICAL RISE AIR WASH

creases with increased diameter of holes. Comparing the values for the different-sized laterals in the table it is seen that under the same conditions, the head decreases with increased size of lateral.

The entries of ΣVQ and VQ Max. have been made to show the superiority in respect to uniformity of discharge of certain combinations of size and spacing of holes. ΣVQ, an abbreviation with no mathematical significance, denotes the arithmetical total variation in discharge of the five sections of the lateral, from the mean discharge; while the maximum single variation is designated by VQ Max. Both of these quantities are expressed in percentages. When $\Sigma VQ + VQ$ Max. = 35 or less, the results are satisfactory.

For washes up to 30-in. vertical rise per minute, the head required is well within economical limits in combination with the values which the other variables assume in practical design.

The hydraulic tests were made in detail on 3-in. and on 2½-in. laterals. The latter size is believed to be the smallest that should be employed for lengths above 10 ft., as it was found that with a decrease in diameter of lateral the conditions favoring a uniform discharge were more difficult to obtain; moreover, the total head required increases with a decrease in diameter of lateral. A 3-in. lateral possesses as satisfactory hydraulic characteristics, for the length tested, as a 3½-in. or 4-in. lateral; and because it may be spaced at a greater distance apart than the 2½-in. lateral for the same loss of head, its use is not materially more expensive in first cost.

In the design of laterals of the perforated-pipe type elsewhere it has been considered that their length should not exceed 6 to 8 ft. if conditions governing uniform discharge were to be realized. Accordingly it was thought that if the width of the filter box exceeded this distance materially, the use of the perforated-pipe lateral would be precluded. The present experiments demonstrated, however, that, other conditions being equal, the uniformity of discharge is dependent upon the correct ratio of the length of lateral to its diameter. In the case of the laterals tested, this ratio is L/D = 34 to 56, where L = effective length of lateral between first and last perforations in inches, and D = actual internal diameter of lateral in inches.

Above the upper limit of L/D noted the discharge tends to become irregular. The ratio for the lateral to be adopted for use at Sacramento equals 45. If a lateral of 4-in. size were used, its length might properly be increased to 16 ft.

Considerable latitude is permissible in the selection of the sizes and spacings of perforations. At proper spacings, uniform discharge is obtainable through holes of from ¼ to ½ in. in size. The spacings corresponding to this range vary from 3 in. to 8 in., so as to give a ratio of total hole area in a lateral (a) to the cross-sectional area of the lateral (A) of from 0.25 for the smallest holes to 0.50 for the largest holes. The head required varies inversely as this ratio and practically the same for equal ratios. Hence for economy in head requirements, the larger sizes of holes at the greater spacings are preferable. The ratio a/A adopted in the Sacramento design is 0.49, being made up of 7/16-in. holes at 6-in. spacing. If the size and spacing of the holes are properly proportioned, the uniformity of discharge is practically unaffected by changes in the rate of wash.

The discharge from the laterals, or the rate of wash (R_w), may be varied from 6 in. to 36 in. vertical rise per minute with the assurance of uniform distribution and freedom from disturbance of the gravel.

The spacing of laterals is dependent upon the minimum allowable ratio of total hole area in the underdrain system (Σa) to filter area and upon the maximum head available. Using 18 in. of graded gravel, the above ratio may be made as low as 0.0021, corresponding to approximately 0.3 sq.in. per sq.ft. of filter.

FIG. 5 DETAIL OF FIG. 4 TAKEN WITH SHORT TIME EXPOSURE

This allows a lateral spacing of 12 in. for 7/16-in. holes 6 in. apart. A lateral spacing greater than 12 in. would usually be inadvisable or impossible because of the increased head demanded.

The perforated-pipe lateral is designed primarily to insure a satisfactory water wash, although an air wash may be applied through the same system with effective results in respect to distribution, provided the rate be not materially less than 4 cu.ft. per sq.ft. of filter per minute. Such high rates have already been attained in practice, and in the present experiments no disturbance of the gravel bed was noted below the top layer of ⅛ to ¼-in. size.

Based upon the results of the foregoing experiments, values for the most important design factors for this type of rapid sand filter underdrain system may now be tabulated as follows:

L/D should not exceed 60.
d, diameter of perforations, should be selected between $\frac{1}{4}$ and $\frac{3}{8}$ in.
S_h spacing of perforations, varies from 3 in. for $d = \frac{1}{4}$ in. to 8 in. for $d = \frac{3}{8}$ in.
a/A should not exceed 0.50 for $d = \frac{3}{8}$ in., and should decrease to 0.25 for $d = \frac{1}{4}$ in.
a/filter area may be as low as 0.002 or 0.3 sq.in. per sq.ft. of filter.
S_L spacing of laterals, may be as great as 12 in. for satisfactory diffusion, but is limited by the total head available.
A gravel bed depth of 18 in., composed of graded sizes, insures excellent diffusion of wash-water.
R^W may be varied from 6 to 36-in. vertical rise per minute with satisfactory results in regard to distribution of wash, provided the foregoing factors are employed in the design.

The present investigation was made by the writer, assisted by C. L. Knight, field engineer, and under the direction of Prof. Charles Gilman Hyde, chief consulting engineer, C. G. Gillespie, resident engineer, and H. B. Foster, assistant hydraulic and filtration engineer, Filtration Division, Sacramento.

Street Cleaning and Related Work in Philadelphia

City Has Taken Over Street Cleaning, Garbage, Ashes and Refuse Collection in Two Districts and Garbage Reduction Works

By James W. Follin
Engineer, Bureau Municipal Research, Philadelphia, Pa.

BEGINNING Jan. 1, 1921, street cleaning and the collection of ashes, rubbish and garbage were undertaken in Philadelphia by municipal forces in two of the thirteen new street cleaning districts. The remaining districts are under one-year contract. This is the first time that municipal forces have been employed on this kind of work in Philadelphia for over forty years. An act of the Pennsylvania assembly of the year 1874 required that all work to be done for the city should be performed by competitive contract. The new charter requires that both street repair and city cleansing work must be done by the city itself unless contract work is approved by both the council and the mayor.

The two districts in which municipal work has been undertaken are in the center of the city and include the most frequented section, the retail business section. However, the city-cleaned districts include sections having greatly varying conditions and the results of the work will furnish an excellent index to what the city can accomplish in the districts still under contract. The total street mileage in the city-cleaned districts is about 15 per cent of the total mileage of paved streets in the city, but the amount of street cleaning work done somewhat exceeds this percentage because the frequency of cleaning is greater than in the contract districts.

The city has practically outfitted anew in mechanical equipment. No change has been made in the types of equipment which have been used for a number of years. The chief dependence in street cleaning is still upon horse-drawn machine brooms and motor flushers. However, the quantity of equipment has been considerably increased over that formerly used by the contractors in the same area. The number of block men has been increased about 10 per cent but the use of block men is still less than that of some other cities.

The bulk of the collection equipment for ashes and rubbish in the municipal districts was purchased from the former contractor. However, 35 new wagons were bought from the Troy Wagon Co. Ten new five-ton trucks with 6-yd. steel bodies were also purchased—five Mack with square bodies and five White with bodies having a fan-tail end similar to the New York type.

In the collection of garbage old equipment is being used throughout. Previously to this year the garbage had been collected and disposed of under a one-year contract. The company gave out the collection to subcontractors. Negotiations are almost completed for the purchase by the city of the garbage reduction plant, collection wagons, and other facilities owned by the Penn Reduction Co. These facilities are under lease by the city for the month of January, and their purchase at a price of $500,000 is being considered by the City Council. While opposition was at first expressed to the price named, it is expected that the purchase will be approved at that price. Garbage is being collected by municipal forces in the two city-cleaned districts and by one-year contract in the remaining eleven districts. These contracts are distinct from those for the joint work of street cleaning and ash and rubbish collection. The city furnishes the collection wagons to the garbage contractors. Private collectors are not permitted except as agents of the contractors. A certain section in the center of the city has been designated a closed area, and private collectors are permitted in this section only under permit of the Board of Health for the collection of garbage from hotels and restaurants. The city also contracts for the transfer by barges of the garbage from a collecting wharf to the reduction plant.

No changes have been made in the methods of disposal of ashes and rubbish. These materials are placed on dumps leased by the contractors. It is stated in the contracts that the collected materials are the property of the city, and the contractor may be called upon to haul them to salvage plants if the average haul shall not exceed that to the dumps specified by the contractors in their bids. It is expected that some action will be taken by the Bureau of Highways later in the year in the direction of refuse reclamation.

The contracts for street cleaning and ash and rubbish collection in eleven districts for 1921 total $3,895,424. Adding to this the estimated cost of the work by municipal forces in the two city districts of $1,280,000, gives $5,175,424. This total exceeds the 1920 cost by $829,020. The estimated cost of the work in the two city districts is $200,000 less than the bids for these same districts. The total cost of collection and disposal of garbage in 1920 was $750,000. It is expected that this cost will be reduced in 1921.

The past year has been a busy one in Philadelphia in developing plans to meet the requirements of the new charter. An appropriation was made by council of $25,000 to carry on an investigation. A special force was organized to collect and assemble the necessary material and a trip of investigation was made to a number of the larger American cities by a committee of engineers. (See *Engineering News-Record*, July 29 and Aug. 19, 1920, pp. 236 and 357.)

The city cleansing work is performed by the Bureau of Highways of the Department of Public Works. Fred C. Dunlap is chief of this bureau, while John H. Neeson is deputy chief in charge of street cleaning. E. D. Very, formerly of the Department of Street Cleaning, New York City, is engineer on street cleaning work.

Long-Span Concrete Roof Arches for Chicago Garage

Arch Ribs Built as Polygons Save Expense in Forms—Cost Little More than for Wood Truss—Cold Weather Concreting

THE largest concrete roof arches ever built are believed to be those of a Chicago garage, the arch ribs of which have a span of 103 ft. 7½ in. over the outer faces of the supporting piers. The building is a motor truck garage and distributing station at 4820 Cottage Grove Ave. for the dry-goods firm of Mandel Brothers. It is 103 ft. 7½ in. x 161 ft. 4 in. in plan and it was desirable to obtain an unobstructed floor area and ample exterior light at reasonable expense. There are eight concrete arches of the span noted, supported on pilasters in the brick walls; at one end is a 65-ft. arch on concrete columns, in order to allow of an upper floor across this end of the building. All arches have a rise of 17 ft. and are spaced 16 ft. c. to c. Fig. 1 shows the construction and Fig. 2 an interior view of the completed structure.

Each main arch is a concrete rib 11½ x 24 in. in section with a short vertical stem at each end seated on a concrete cap on the 17-in. brick pilaster. It is reinforced by three ⅞-in. rods in top and bottom, with stirrups spaced 3 ft. apart, the longitudinal rods being hooked into a spiral at each end of the arch and having their ends hooked at the lap splices. The intrados has nominally a radius of 90 ft. but actually the arch is polygonal, with 10-ft. sides, this arrangement avoiding the expense of curved form work. In the 65-ft. arch the radius is 42 ft. A single 2½-in. tie rod with turnbuckles forms the lower chord. At each end of the tie rod is a nut and bearing plate, the plate at one end taking a bearing against the steel spiral and being embedded in the concrete, while at the other end the plate bears against the outer face of the rib. This rod is 14 ft. above the floor, and to prevent sagging it is supported by five ⅝-in. hooked hangers whose upper ends are fitted with washers and embedded in the arch rib. Turnbuckles provide for adjustment of the hangars. Details of the ribs and forms are given in Fig. 3

On each side of the crown are two lines of longitudinal concrete beams or struts, 8 x 6 in. section, formed between the ribs and extending to the end walls. Upon these rest the wood framing of continuous skylights or monitors 12 ft. wide. This arrangement gives a good distribution of light over the entire floor area, as the roof design eliminates all interior obstructions. Pivoted sash in the sides of the monitors provides for ventilation.

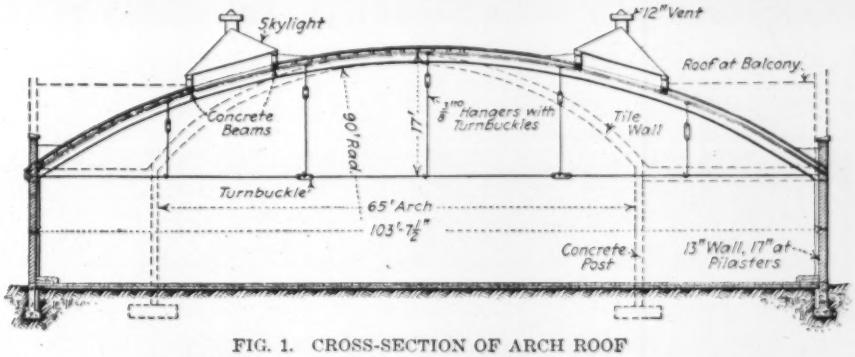


FIG. 1. CROSS-SECTION OF ARCH ROOF

Wood rafters were planned originally to be carried by timber strips bolted to the sides of the arch ribs,

FIG. 2. CONCRETE ARCHES OF 103½-FT. SPAN CARRY ROOF OF GARAGE

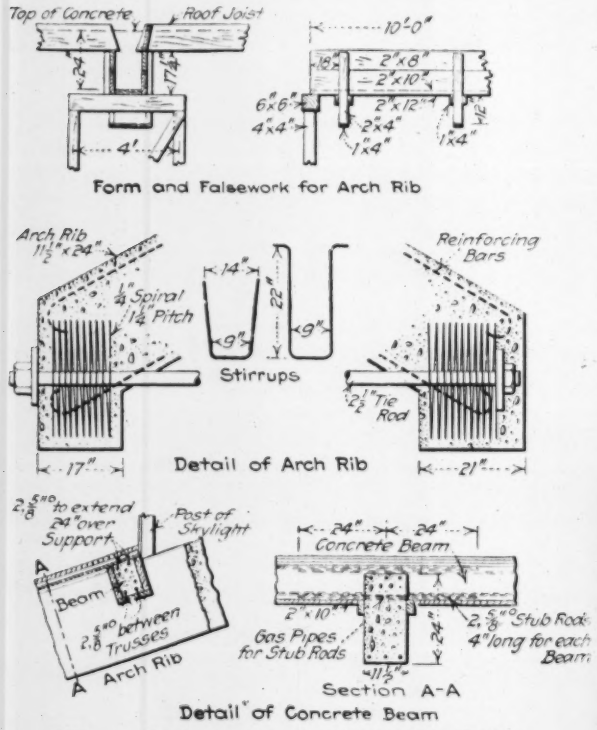


FIG. 3. DETAILS OF ARCH RIB AND FORMS

but a simpler construction was adopted by seating the ends of the rafters in the ribs. For this purpose the rafters were supported by the forms and the concrete was poured around them. They are 2 x 10 in., spaced 2 ft. c. to c. The roof sheathing consists of two layers of ⅞-in. matched and dressed boards placed transversely and separated by 2 x 2-in. strips extending across the arch, the air space thus formed serving for heat insulation and preventing the condensation of moisture on the inner side. A layer of building paper is laid upon the inner sheathing, and over the outer sheathing is placed a felt and pitch roofing. Across one end of the building is a balcony carried by wood joists seated in the end wall and in stirrups on hanger rods whose upper ends are embedded in the 65-ft. arch rib.

For each rib the form was supported on a timber frame or falsework, having bents spaced 10 ft. c. to c. The roof joists or rafters were seated in notches in the sides of the form (see Fig. 3), and at the middle of the span the first layer of roof sheathing was laid on the joists to serve as a platform for the concreting wheelbarrows. Planed 2-in. lumber was used for the forms, which were made watertight. This falsework construction was adopted partly because the work was done during the winter, as it permitted the entire area to be covered before concreting was commenced.

A rich and rather dry concrete mix of 1:1:2 was used, with ¾-in. stone as the coarse aggregate. This was partly for strength and partly in view of the cold weather. No salt was used, but the water and materials were heated and salamanders were kept burning on the floor. Two of the ribs were poured on a cold day and zero temperature was reached the same night, but the concrete was not affected. Forms were left in place for 60 days. A mixer at one end of the building discharged the concrete into wheelbarrows which were hoisted to the roof platform and dumped into the forms, filling the ends first and then working toward the crown. The concrete was well rodded to ensure density and close contact with the reinforcing steel.

A snow load of 25 lb. per square foot was the live load element in the design. Compression in the concrete is taken at 750 lb. per square inch. Owing to the high cost of lumber the cost of the nine arches was only about $800 more than that of wood lattice trusses such as are used frequently in buildings of this kind, but the trusses would have formed considerable obstruction to proper distribution of light.

The arch ribs were figured first for the full dead load and for the live load over the entire span, which condition of loading determined the greatest horizontal thrust. The greatest bending moment in the arch was assumed to occur when the live load is acting on one-half of the arch. This moment is positive in the loaded quarter point and negative in the unloaded quarter

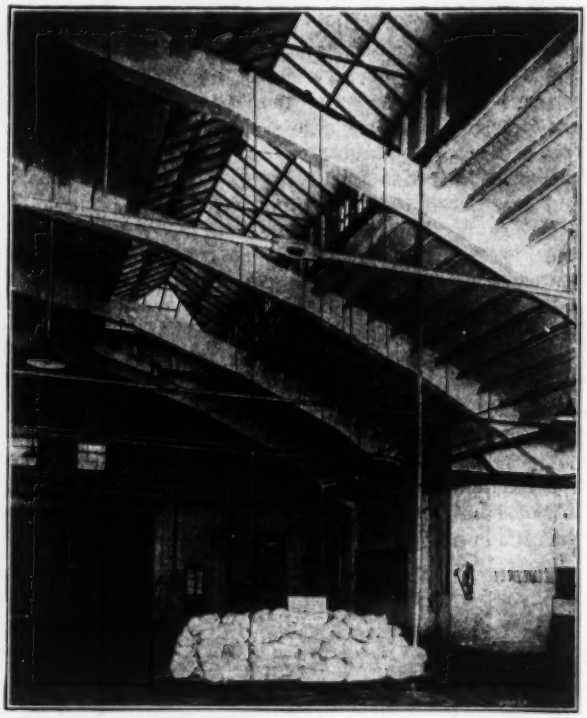


FIG. 4. TESTING CONCRETE ROOF ARCHES

point. Combining this bending moment with the thrust from the total dead load and the live load on one-half of the span determined the critical or most dangerous section of the arch.

One of these arches was tested at the demand of the Chicago Building Department, being subjected to a test load of 12,000 lb. concentrated at one quarter point of the span. This test was made with a platform 8 x 10 ft. hung from the arch by three sets of ⅝-in. cables and loaded with 125 bags of cement, as shown in Fig. 4. Assuming the arch to act as hinged at the two abutments the greatest deflection occurs at the loaded point. According to the elastic theory the quarter point of the unloaded side should have a rise equal to the downward deflection of the loaded point, while the crown of the arch should not show any vertical deflection. Assuming a modulus of elasticity of 3,000,000 the formula gives a deflection of ⅝-in.

In the test, the deflection immediately after the load was applied amounted to ¼-in. at the loaded point and

zero at the crown, with $\frac{1}{16}$-in. rise at the quarter point of the unloaded side. These values increased to $\frac{3}{8}$-in. and $\frac{1}{4}$-in. at the quarter points after 24 hours, the crown still showing no deflection. Immediately after removing the loads the nonelastic deflection was $\frac{1}{4}$-in. and $\frac{1}{16}$-in. at the loaded and unloaded points, respectively.

The architect and superintendent for this building was I. S. Stern, Chicago. The concrete arches were designed and constructed by L. J. Mensch, Chicago.

Effect of Worn Runners on Dredge Pump Efficiency

Comparative Tests of New and Worn Runners Show Economic Necessity of Providing for Prompt Replacement

By Ivan E. Houk
Assistant Engineer, Miami Conservancy District, Dayton, Ohio

PROMPT replacement of worn pump runners has been made a rule in pumping hydraulic fill at the flood protection dams of the Miami Conservancy District. Tests of the dredge pump at the Taylorsville dam made on several different dates in the early stages of the work and under several different conditions indicate the reason for this practice. The observed and calculated data of these tests are given in Tables I, II and III. Table I gives the data obtained while using a 39-in. cast-iron runner; Table II gives that obtained using a 37-in. cast-iron runner, made by cutting off the ends of the vanes of a 39-in. runner, with an acetylene torch; and Table III gives that obtained using a 34-in. manganese-steel runner with diameter increased to 36 in. by shoes. A cross-section of the pump is shown by the drawing. The motor is a 350-hp. three-phase 60-cycle induction motor having a full load speed of 505 r.p.m.

TABLE I. TESTS OF 15-IN. DREDGE PUMP WITH 39-IN., 4-VANE CAST IRON RUNNER

Speed in R.P.M.	Friction Head in Disch. Pipe, in Ft.	Total Head on Pump, in Ft.	Velocity in Feet per Sec.	Discharge in Sec. Ft.	Hp. Output	Hp. Input	Plant Efficiency in per Cent	Motor Efficiency in per Cent	Pump Efficiency in per Cent
Test of March 29, 1919; length of line, 2010 ft.; runner, new; static lift, 6 ft.; average pump efficiency, 56.8 per cent									
267	29.7	36.7	7.62	9.37	39.0	129	30.2	46.7	64.7
288	38.9	46.4	8.71	10.7	56.3	185	30.4	52.4	58.0
322	48.2	56.6	9.69	11.9	76.4	226	33.8	59.0	57.3
346	52.9	62.1	10.2	12.5	88.2	258	34.2	63.6	53.7
354	59.8	69.9	10.8	13.3	106	290	36.5	66.9	54.5
390	71.3	82.8	11.8	14.5	136	338	40.2	71.9	55.9
423	82.9	96.1	12.7	15.6	170	386	44.0	77.9	56.5
454	96.6	110.9	13.7	16.9	213	450	47.3	83.4	56.7
504	112.6	129.2	14.8	18.2	267	543	49.1	91.7	53.5
Test of April 1, 1919; length of line, 2140 ft.; 2700 cu.yd. pumped by runner; static lift, 7 ft.; average pump efficiency 50.4 per cent									
262	25.5	33.6	6.83	8.40	32.1	140	22.9	46.5	49.5
292	33.6	41.5	7.84	9.64	45.5	193	23.6	53.2	44.4
320	41.6	50.1	8.72	10.7	60.9	203	30.0	58.4	51.4
343	48.6	57.9	9.43	11.6	76.3	232	32.9	63.0	52.1
360	53.2	63.0	9.88	12.1	86.6	258	33.6	66.2	50.8
388	61.2	72.7	10.6	13.0	107	301	35.6	71.4	49.9
421	76.2	88.3	11.8	14.5	145	354	41.0	77.6	52.8
454	91.2	105.0	12.9	15.9	190	430	44.2	83.4	53.0
490	102.8	118.9	13.7	16.8	227	515	44.1	89.4	49.3
Test of April 29, 1919; length of line, 1750 ft.; 2700 cu.yd. pumped by runner; 17,000 cu.yd. pumped by shell with 37-in. runner since April 1; static lift, 8 ft.; average pump efficiency, 53.9 per cent									
270	27.8	37.2	7.89	9.70	41.0	148	27.7	48.0	57.7
300	34.8	45.6	8.83	10.9	56.5	184	30.7	54.5	56.3
330	42.6	54.8	9.75	12.0	74.8	225	33.2	60.5	54.9
350	48.2	61.1	10.4	12.8	88.9	254	35.0	64.3	54.4
370	54.1	68.1	11.0	13.5	104	285	36.6	68.1	53.7
395	62.2	77.3	11.8	14.5	127	326	39.0	72.8	53.5
428	73.5	90.1	12.8	15.7	161	388	41.5	78.8	52.6
450	85.1	103.1	13.8	17.0	199	455	43.7	84.4	51.8
492	97.2	117.1	14.7	18.1	2.41	537	44.9	89.7	50.1
Test of May 25, 1919; length of line, 1340 ft.; runner worn out; 22,000 cu.yd. pumped static lift, 13 ft.; average pump efficiency, 44.8 per cent									
287	14.1	30.8	7.50	9.23	32.3	155	20.8	50.8	40.9
318	21.7	38.2	8.82	10.8	47.1	191	24.6	57.4	42.8
350	29.2	46.2	10.2	12.5	65.6	232	28.3	63.7	44.4
368	33.4	51.0	10.9	13.4	77.6	257	30.2	67.2	44.9
385	37.7	55.6	11.6	14.3	90.4	283	31.9	70.5	45.2
408	43.0	62.0	12.5	15.4	10.9	321	33.8	74.8	45.2
438	50.2	71.0	13.8	17.0	13.7	371	36.9	80.2	46.0
475	59.2	82.2	15.4	18.9	176	438	40.3	86.7	46.5
508	67.0	92.8	16.7	20.6	217	502	43.2	92.0	47.0

TABLE II. TESTS OF 15-IN. DREDGE PUMP WITH 37-IN., 4-VANE CAST IRON RUNNER

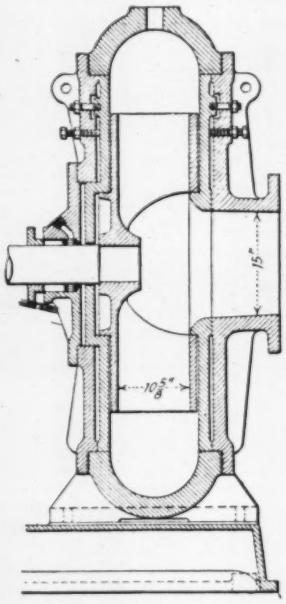
Speed in R.P.M.	Friction Head in Disch. Pipe, in Ft.	Total Head on Pump, in Ft.	Velocity in Feet per Sec.	Discharge in Sec. Ft.	Hp. Output	Hp. Input	Plant Efficiency in per Cent	Motor Efficiency in per Cent	Pump Efficiency in per Cent
Test of April 2, 1919; length of line, 2170 ft.; runner, new; static lift, 6 ft.; average pump efficiency, 50 per cent									
262	24.7	32.6	6.68	8.21	30.4	129	23.6	45.9	51.4
313	32.8	41.0	7.69	9.46	44.1	158	27.9	56.0	49.8
343	40.9	49.7	8.58	10.6	59.8	190	31.5	62.4	50.5
365	45.5	54.9	9.06	11.1	69.3	213	32.5	66.7	48.7
381	51.3	61.2	9.61	11.8	82.1	236	34.8	69.9	49.8
406	57.0	68.1	10.1	12.4	96.0	278	34.5	74.8	46.1
435	69.7	82.5	11.2	13.8	129	322	40.1	80.2	50.0
465	82.4	96.9	12.2	15.0	165	374	44.1	85.6	51.5
503	96.2	111.6	13.2	16.2	206	427	48.2	92.5	52.1
Test of April 2, 1919; length of line, 1220 ft.; 700 cu.yd. pumped by runner; static lift, 5 ft.; average pump efficiency, 53.8 per cent									
266	20.5	27.2	9.12	11.2	34.8	136	25.6	46.8	54.7
300	27.4	35.3	10.5	12.9	51.8	174	29.8	54.3	54.9
328	33.2	42.5	11.6	14.3	69.1	213	32.4	60.0	54.0
349	37.8	47.9	12.4	15.2	82.7	241	34.3	64.2	53.4
368	42.4	53.1	13.1	16.1	97.8	274	35.7	67.8	52.6
397	49.3	61.1	14.2	17.4	121	311	38.9	73.1	53.2
433	55.1	69.2	15.0	18.5	145	380	38.1	79.8	47.8
461	68.8	84.6	16.7	20.6	198	435	45.5	84.6	53.8
497	86.2	104.3	18.7	23.0	273	500	54.5	90.9	59.9
Test of April 22, 1919; length of line, 1750 ft.; runner worn out, 17,000 cu.yd. pumped; static lift, 8 ft.; Average pump efficiency, 43.8 per cent									
299	22.8	33.4	7.24	8.90	33.8	135	25.0	52.5	47.6
327	29.7	40.5	8.04	9.89	44.3	162	27.3	58.7	46.5
358	34.8	45.9	8.87	10.9	57.3	197	29.1	65.3	44.5
376	38.9	50.6	9.34	11.5	66.3	219	30.3	68.9	44.0
391	42.9	55.1	9.80	12.1	75.2	240	31.3	71.7	43.6
420	48.9	61.7	10.6	13.0	92.5	280	33.0	77.4	42.5
445	56.9	70.8	11.3	13.9	111	319	34.8	81.9	42.5
472	65.5	80.6	12.0	14.8	133	368	36.1	86.9	41.5
501	72.4	88.6	12.9	15.9	162	423	38.3	92.1	41.6

Making proper correction for elevations of gages the total head on the pump and the friction head in the pipe line were determined by readings of carefully calibrated suction and pressure gages. Velocities for the measured friction head per 100 ft. were taken from the tests described in *Engineering News-Record*, Jan. 6, 1921, p. 18, using the test for which the conditions were most similar. The power input to the motor was obtained by counting the revolutions of the disk of an integrating watt-hour meter. Speeds were measured by an ordinary speed indicator held on the end of the motor shaft. Motor efficiencies for different speeds were furnished by the manufacturers. Observations at a given speed were taken simultaneously and were repeated in all cases.

In working up the data for a given test the different determinations of friction head, total head, and power input were plotted against the speed, and the points balanced by smooth curves. The quantities given in the tables were taken from these curves. In this way some of the small observational discrepancies were eliminated. It might be stated, however, that in no instance were these discrepancies of appreciable magnitude. The work was carefully done throughout. Although the

results are not as accurate as would be expected in performance tests of high-grade centrifugal water pumps, the writer believes that they are much more accurate than most dredging data.

Reference to Table I shows that the average efficiency of the pump with the 39-in. runner was reduced from about 57 per cent when the runner was new, to about 45 per cent when the runner was worn out. During this time the pump handled about 40,000 cu.yd. and the runner, about 22,000 cu.yd. The pump had handled about 36,000 cu.yd. when the 39-in. runner was installed. On April 1 1919, after the runner had handled about 2,700 cu.yd. the propelling area of each vane was found to have been reduced by wear about 22 sq.in. When the runner was discarded this wear amounted to about 81 sq.in. The wearing was confined entirely to the inner ends of the vanes and was probably due to the impact of the rocks in getting into the runner. The material handled was clay, sand, and gravel with a preponderance of clay. A mechanical analysis of a typical sample showed that about 10 per cent by weight was retained on a ¼-in. screen and that about 50 per cent of the remainder passed through a 200-mesh sieve.



CROSS-SECTION OF 15-IN. DREDGE PUMP FOR HYDRAULIC FILL AT TAYLORSVILLE DAM

Table II shows that the average efficiency of the pump with the 37-in. runner was reduced from about 50 per cent to about 44 per cent, by the wearing down of the runner vanes, the latter figure being practically the same as for the worn-out 39-in. runner. However, the efficiency when the 37-in. runner was first installed was somewhat lower than in the case of the new 39-in. runner, due possibly to the larger flow space between the outer ends of the vanes and the pump shell as well as to the rather rough manner in which the vanes had been cut off. About 105 sq.in. had been worn off of each vane of the 37-in. runner when it was discarded.

TABLE III. TEST OF 15-IN. DREDGE PUMP WITH 36-IN., 4-VANE MANGANESE STEEL RUNNER

Test of May 28, 1919; Length of line, 1414 ft.; runner new; Static lift, = 12 ft.; average pump efficiency, 62.3%

Speed in R.P.M.	Friction Head in Disch. Pipe, in Ft.	Total Head on Pump, in Ft.	Velocity in Feet per Sec.	Discharge in Sec. Ft.	Hp. Output	Hp. Input	Plant Efficiency in per Cent	Motor Efficiency in per Cent	Pump Efficiency in per Cent
293	24.5	40.0	9.10	11.2	50.9	141	35.1	51.2	70.5
316	28.6	45.4	9.79	12.0	61.9	174	35.6	55.4	63.1
342	34.3	52.6	10.7	13.2	79.0	211	37.4	61.8	60.5
363	39.4	58.9	11.6	14.2	95.0	242	39.2	66.1	59.3
384	44.7	65.6	12.5	15.3	114	274	41.6	70.2	59.3
400	48.9	71.0	13.2	16.2	131	300	43.7	73.3	59.6
435	59.0	83.0	14.8	18.2	172	357	48.2	79.7	60.5
470	70.0	96.0	16.7	20.5	224	413	54.1	85.8	63.0
497	78.6	106.2	18.1	22.2	268	457	58.6	90.7	64.6

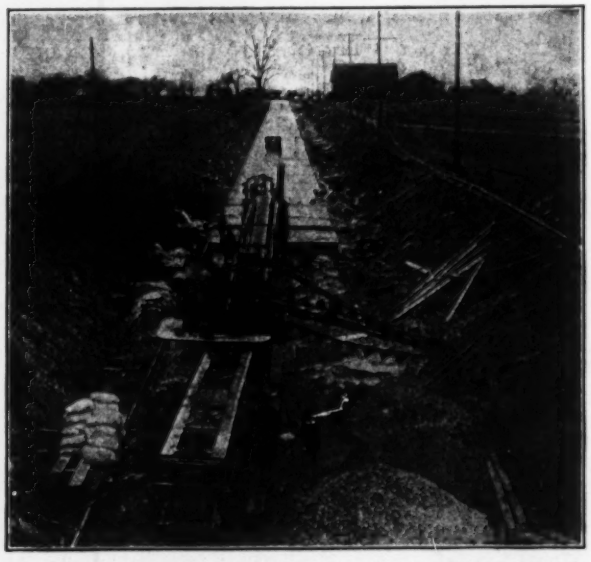
The data in Tables I and II seem to indicate that the efficiency was higher when pumping through the shorter pipe lines, which seems reasonable, since for such conditions the discharges were greater and the heads smaller. Unfortunately it was not feasible to vary the head and discharge through a certain pipe line without varying the speed.

Both of the runners mentioned above were cast-iron runners which were furnished with the first pumps obtained. This accounts for the comparatively short life. Manganese-steel runners with detachable shoes were later adopted because of their much longer life. They are now being used at all locations. The average efficiency of the Taylorsville pump with a new manganese-steel runner was about 62 per cent, as shown in Table III, or about 5 per cent higher than with the new 39-in. cast-iron runner. However, the test recorded in Table III was made with a pipe line 1,414 ft. long whereas the test with the new 39-in. cast-iron runner was made with a line 2,010 ft. long. The efficiencies would probably have been about the same if the tests had been made with the same length of line.

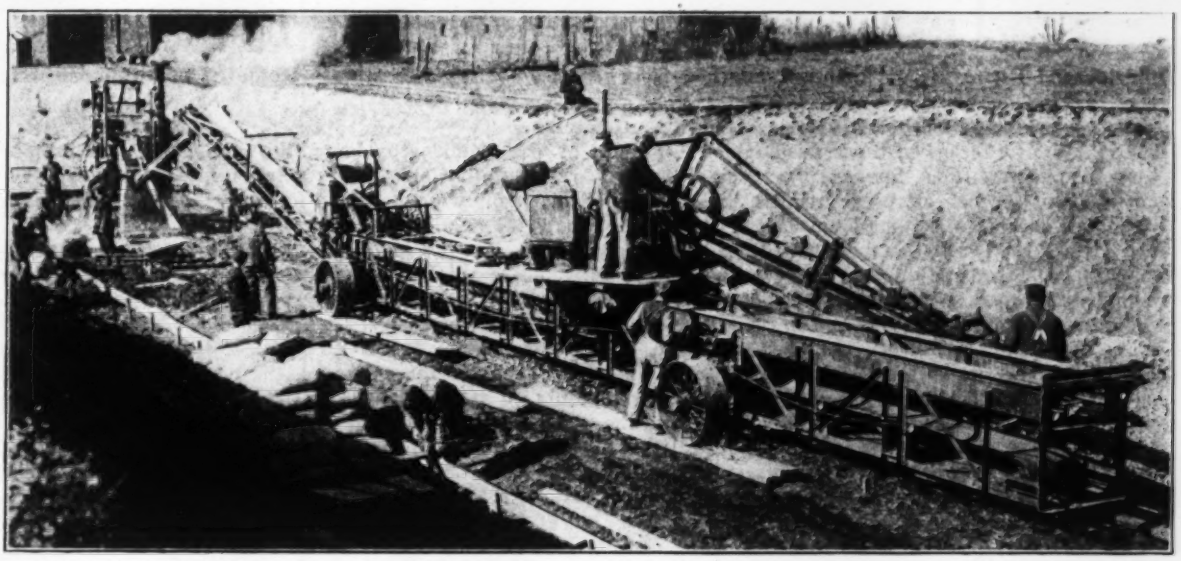
The tests described were made with the co-operation of the division engineers, O. N. Floyd and H. S. R. McCurdy, at the Taylorsville and Englewood dams respectfully, at times when the work would interfere least with the construction progress. Arthur E. Morgan is chief engineer of the Miami Conservancy District, Charles H. Paul, is the assistant chief engineer and C. H. Locher is the construction manager.

Mechanical Mixer Loader Facilitates Paving Operation

A MECHANICAL loader, which picks up the aggregate from ground piles, measures it to correct proportions and conveys it to the mixer, was a notable element this season in a paving operation near Carrollville, Wis., for which the Jacobus & Winding Construction Co. of Milwaukee was the contractor. By the use of this machine the crew was reduced to 13 men. Due to the absence of shoveling and wheeling, soft



(1) END VIEW OF LOADER AND MIXER, STOCK PILES ON ONE SIDE



(2) END INCLINE LEAVES CLEAR SPACE FOR TRIMMING SUBGRADE

sub-grade caused little trouble. Only falling rain stopped the work, if the materials were on the ground. Construction in cuts, with rain every few days, gave ample opportunity for these facts to be determined and verified.

Two views of the outfit are given from which a fairly clear idea of its appearance and general arrangement is had. The loader consists of a long framework, mounted on self-propelled trucks, which carries a rubber belt conveyor which discharges the material through a chute into the mixer skip. On the top of this framework a bucket elevator is mounted so as to move back and forth along the frame to adjust it into working relation to the piles of sand and stone on the subgrade. Underneath this elevator and above the belt conveyor, a hopper is mounted, which is divided into a number of compartments and is movable along the frame so that anyone of these compartments may be placed in position for the elevator to discharge into it.

In operation the elevator first fills a series of sand hoppers sufficient for eight batches and then moves into position to elevate stone, for which two hoppers are provided. When the elevator fills a stone hopper it is discharged, together with a sand hopper, onto the belt and carried to the mixer. When the last sand hopper is discharged, the elevator is moved to the sand pile and refills the eight sand compartments. During this time the two compartments of stone are ready for delivery to the mixer so that no delay results in changing the elevator from one pile to the other.

The material is spouted into the mixer skip by means of a swivel chute pivoted at the end of the framework. The purpose of this chute is to enable the material to be spouted well toward the inside of the skip and also to allow considerable variation between the mixer and loader so that exact alignment is unnecessary. This saves time in moving. It is to be noted, also, that the inclined section of the conveyor extends to a height of about 12 ft. and permits a length of about 30 ft. between the skip of the mixer and the wheels of the loader for finish grading, with sufficient head-room for men to work without danger. Although the subgrade was in exceptionally bad condition and needed considerable trimming, still this 30 ft. of working space was all that was ever required.

Trucks delivered the material in piles at one side of the road, four piles in fifty feet—sand and stone alternately. The range of the elevator being a little over 50 ft. enabled it to work on any one of four piles with one setting of the machine. Considerable additional range is provided by the swivel chute which can be extended either forward or backward to discharge the material into the mixer skip. In this way a total variation of 70 ft. is possible in the piles. This is approximately 20 per cent of a day's run. It was found that materials never varied more and it was hardly ever necessary to work at the extreme points.

By placing material on one side of the road, the other side was left open for bringing up additional material and cement. On this job sufficient room was left between the loader and the forms to bring up cement in wagon loads and pile it within 20 ft. of the mixer. The piles of sand and stone were approximately 12 ft. wide, two to three truck loads being dumped on each pile. These were almost completely picked up by the elevator, only one man being required for cleaning up.

The crew consisted of 13 men, placed as follows: One finisher; two men spreading mixed concrete and laying reinforcing; one mixer engineer; one fireman (helped on loader chute); two cement men; two men for preparing the grade; one loader engineer; one man operating hoppers on the loader; one man cleaning up material piles; and one form setter. This crew required considerably less supervision than the ordinary mixer crew, chiefly because only half as many men were required and most of these were skilled workmen who in turn set the pace for the laborers.

Weather conditions and other delays beyond the control of the contractor, and, later freezing weather, interrupted progress of the job to such an extent that output figures mean very little. The average progress of the work was approximately on the basis of 30 ft. per hour which was the capacity of the mixer. At this rate the loader was idle 30 per cent of the time waitting for the mixer.

Large Railroad Ash-Handling Plants of Two Types

Underground Removal for Through Trains—Overhead Removal at Terminal—Remote Control of Electric Operation—Costs and Comparisons of Service

RADICALLY different methods used under different operating conditions for handling ashes dropped from locomotives when cleaning fires are illustrated in the two new and large ash-handling plants on the Pittsburgh & Lake Erie R.R. At Brightwood, Pa., the ashes from engines of through trains are dropped into hoppers having bottom gates for delivering the ashes to a car traveling in a transverse tunnel and in turn discharging into the skip of an ash hoist. At Haselton, Ohio, the locomotives at an engine terminal drop the ashes into cars in a shallow pit, the car bodies being hoisted out by a trolley on an inclined runway extending across the tracks to the ash bin.

In each case the plant has capacity sufficient to handle the ashes from twelve engines per hour, or about 45 cu.yd. per hour. At Brightwood, with underground operation, the conditions are uniform and only one man per shift is needed in the tunnel for the ash handling plant. At Haselton, with outside or surface operation, from two to three men per shift are needed for equivalent service, the number varying with the weather conditions. At this point, however, the extra capital cost for two long tunnels and the necessary machinery for underground operation would not be warranted.

Underground Ash Handling System

For delivery of coal, water and sand to the engines of through trains, a large plant serving six tracks has been built at Brightwood, Pa., and on four of these tracks the engines can have their fires cleaned at the same time that they are taking water from the standpipes placed between the tracks. The fires are cleaned by the ashpit attendants, the enginemen and firemen remaining in charge of their engines. The layout of this plant was shown in *Engineering News-Record* of July 15, 1920, p. 107.

Ashpits Over Tunnel.—Long pits between the rails would be objectionable in running tracks and the transfer of ashes across and above such tracks would be equally objectionable. To meet local conditions a hopper-bottom ashpit of 225 cu.ft. capacity is placed in each of the four freight tracks, the pit having a length of only 14 ft. and a depth of 8 ft. from the rail to the cut-off gate in the bottom. These pits are of concrete, with firebrick lining. Beneath the ashpits is a transverse concrete tunnel 114 ft. long, 13 ft. wide and 8 ft. high, one end of which opens into the shaft of an ash hoist. The general construction is shown in Figs. 1 and 2. At the river end of the tunnel is the pump house which supplies the water station. The entire concrete structure was built in open-cut and is reinforced for both the earth loads on the roof and side walls and also for external water pressure, as this work is below high-water level in the Ohio River, which parallels the railroad. The concrete is made waterproof, as explained in the article noted above. Inclined hatchways or ladder shafts give access to the tunnel, which has also a recess for a heating stove and a large hatchway for handling machinery.

Heavy reinforced-concrete girders, integral with the roof and walls of the tunnel, carry the running tracks across the tunnel and also form the side walls of the ashpits (see Fig. 2). Upon these girders are placed cast-iron rail chairs of I-section, with anchor bolts in

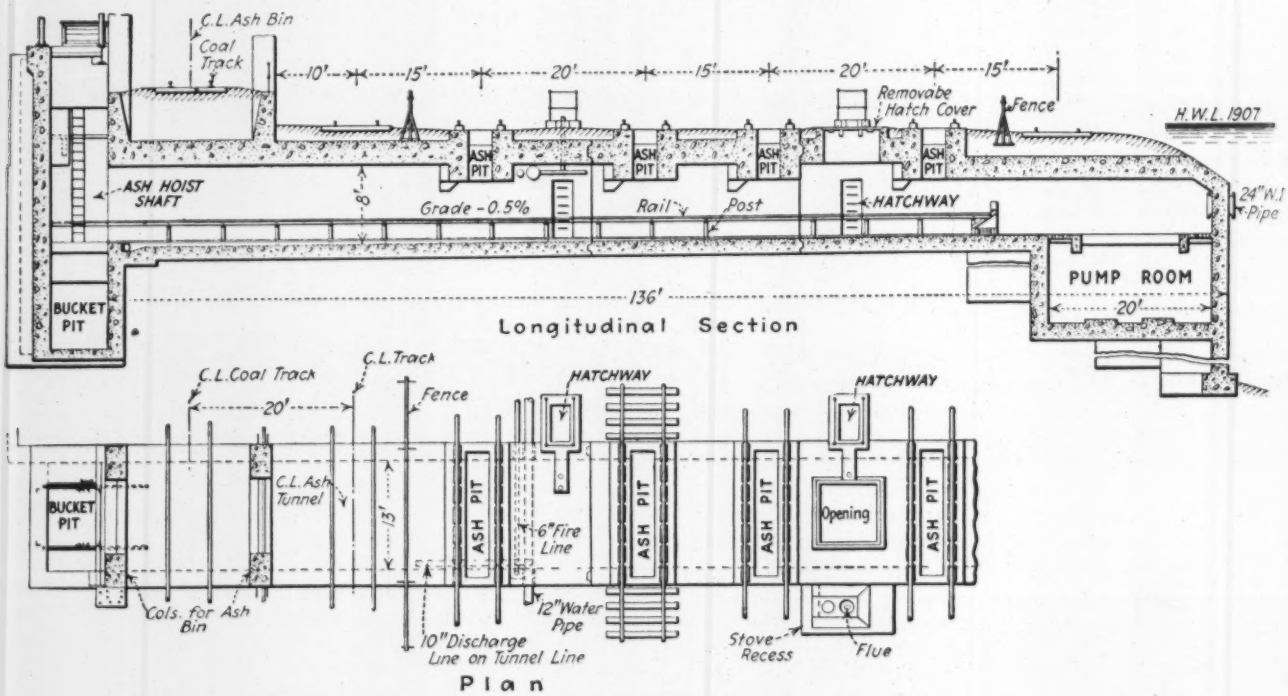


FIG. 1. ASHPITS AND TUNNEL AT BRIGHTWOOD; P. & L. E. R.R.

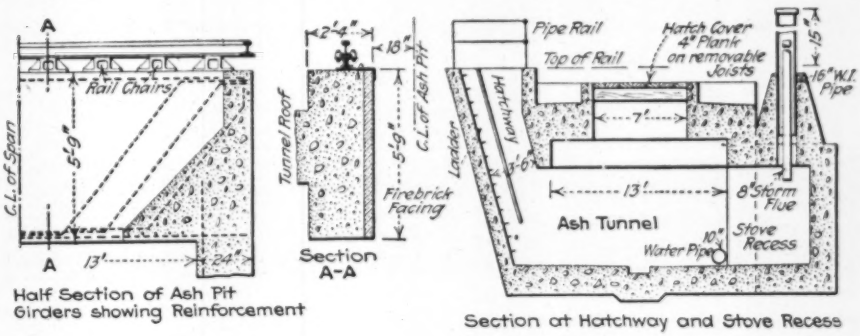


FIG. 2. TUNNEL SECTION AND GIRDER DETAILS

the bottom flanges and clip bolts for the rails in the top flanges. These chairs are placed 29 in. c. to c. and have a bearing 4 in. long for the rails, and 26 in. long on the concrete. The rail clips do not grip the top surface of the rail flange, but allow ¼-in. vertical play, thus preventing the deflection or wave motion in the rail from causing any motion of the rail chair on the concrete. This track construction is shown in Fig. 3.

Ash Car in Tunnel.—A steel, hopper-bottom, motor-driven ash car of 75 cu.ft. capacity travels in the tunnel and is operated by a rider who also loads the car by means of the undercut gates in the bottoms of the four ashpits. Details of the gate apparatus are given in Fig. 4. A track of 7-ft. gage with a grade of 0.5 per cent descending toward the shaft has its 90-lb. rails supported on steel posts spaced 6½ ft. c. to c., the top rail being about 24 in. above the tunnel floor, in order to accommodate the hopper bottom of the car, which lies between and below the rails. Each post is a 4-in. I-beam, 39 in. long, with the lower end grouted into the tunnel floor. At the top are two angles with a cap plate to carry the rails, which are secured by clip bolts passing through the plate and angles, as shown in Fig. 3.

Water is used freely in cleaning the ash-pans of the engines and for cooling the ashes in the pits so that they are not dry or hot when delivered to the car. Water is available also in the tunnel for cooling any unusually hot ashes and for washing the floor and the car, the floor having a gutter and being sloped to carry off all wash water as well as the drainage from the pits. Electric power wires and contact rails are carried along the roof of the tunnel on the side opposite to that on which the operator does all his work, the rails engaging with contact plates supported by an arm on the side of the ash car.

Cast steel wheels with outside flanges carry this car, one axle being geared to a 5-hp. motor, which gives a maximum normal car speed of 250 ft. per minute. Spring buffers on the ends of the car sills engage bumper blocks at each end of the track. On one end of the motor shaft is keyed a wheel for a brake band operated by a treadle. The controller handle, brake treadle and dumping lever are placed convenient to the operator, who stands on a running board on one side of the car. The car and its brake equipment are shown in Fig. 5.

Ash Hoist.—When in its dumping position, the ash car stands in the hoisting shaft (Fig. 1), directly over the skip or elevator bucket. The track gage (7 ft.) is wide enough to allow the skip guides to be placed between the rails, these guides being cut away to allow the front axle of the ash car to pass through. When the car is run back out of the shaft and the hoisting skip is raised, a counterweighted frame or gate automatically rises and barricades the end of the tunnel, so that the ash car cannot be run into the dumping position until the skip bucket has again returned to its loading position and thus carried down the barricading gate to clear the tunnel. The ash car and skip mechanism are interlocked both mechanically and electrically to secure proper operation and to prevent interference. When the car is in position over the skip bucket, the operator releases the gate forming the front end of the car; after the ashes have run out he closes this gate and latches and locks it in one operation.

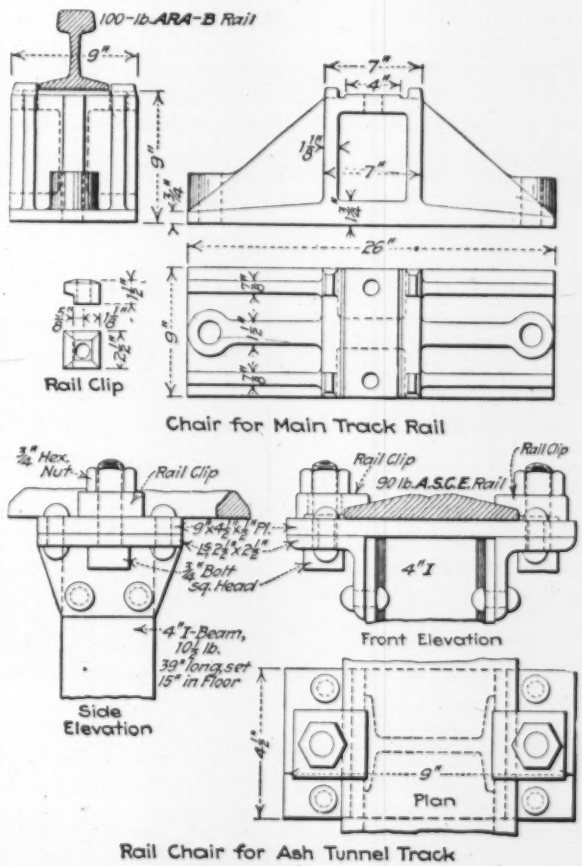


FIG. 3. RAIL SUPPORTS FOR MAIN AND ASH-CAR TRACKS

The hoisting skip has a capacity of 90 cu.ft. and is operated by a 22-hp. motor. At the top of its travel the skip automatically dumps the damp ashes into a hopper-bottom concrete storage bin of 3,500 cu.ft. capacity. This bin, which is emptied daily, is placed above the coal car track of the coaling station, so that cars which have dumped their loads of coal can be loaded with ashes directly from the bin. Each round trip of the ash skip, starting at the bottom of the shaft,

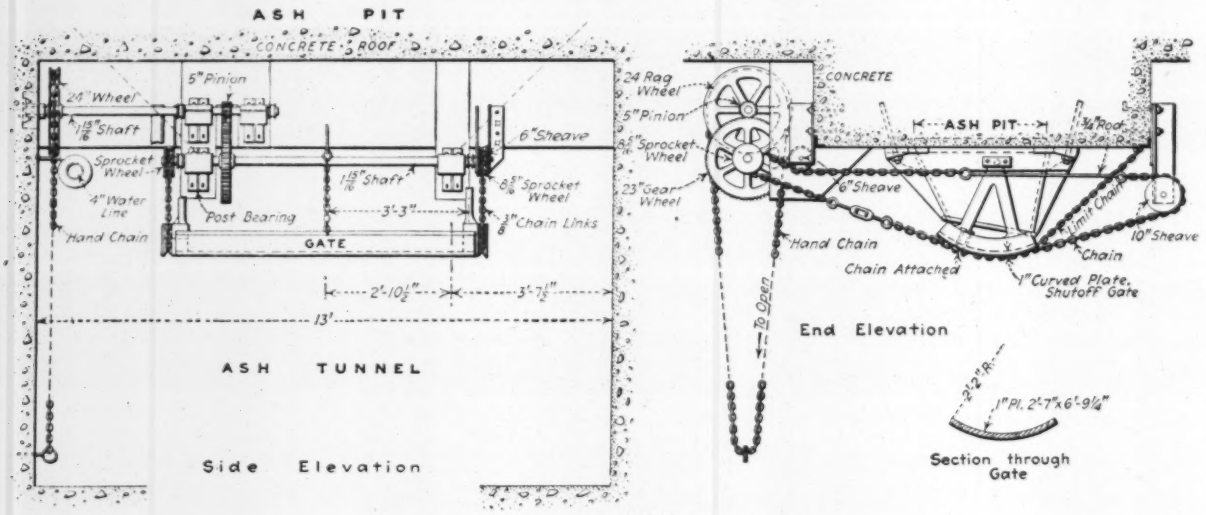


FIG. 4. ASHPIT GATE AND MECHANISM

is effected by the operator pressing a button located on the wall of the tunnel, the button being placed about 20 ft. back from the skip.

About 50 to 90 cu.ft. of ashes are dropped by each engine, the daily total in the fall of 1920 amounting to about 4,200 cu.ft. or 85 tons of dry ashes. By the introduction of the mechanical methods described, one man for each eight-hour shift can remove the ashes from the four pits, receiving ashes from twelve engines per hour, the assumed maximum service being six engines per hour in each direction, at ten-minute intervals. The operator's duty is to keep the pits empty and he has free communication with the men on the surface who are working on the engines.

Ash handling plants of other types serving through trains on this railroad require two or more men on each shift to perform this same duty. With the present wage scale capitalized, there is a capital or investment saving of $75,000 by eliminating three men per day.

As the ash handling plant at Haselton, Ohio, is part of the equipment of an engine terminal, main track conditions were not a factor, as at Brightwood. Low cost with economy and efficiency of operation were the main requirements. Concrete ashpits are located in four parallel tracks extending to the coaling station, sanding towers and water columns, as shown by the layout plan, Fig. 6. These pits are 125 to 152 ft. long, 4 ft. wide, and with a maximum depth of about 5 ft.; they are spaced 17 ft. c. to c. As the site is on filled ground the pit walls are carried below the floor to a single broad footing, which gives a maximum soil loading on clay of less than one ton per square foot. In each pit, the floor is sloped to four low points where sumps connected with four transverse 8-in. drains leading to a 12-in. longitudinal drain beyond the pits. Fig. 7 shows the pits and the ash handling equipment.

Steel cars with removable bodies of 2 cu.yd. capacity travel on a track of 37½-in. gage in the bottom of the ashpit, each pit having twelve cars. The cars are propelled by hand. Cast iron chairs or pedestals spaced about 4 ft. c. to c. are embedded in the concrete floor to carry the 71-lb. rails, the outer edge of the rail base fitting under a lug in the casting and the inner edge being held by a rail clip and bolt at each support. A clear space is provided behind and under these rails to facilitate cleaning out the small amounts of stray ashes that fall into the pit. The main track rails rest on cast-iron chairs spaced about 30 in. c. to c. and resting on the top of the ashpit walls.

Overhead Runways.—Two elevated runways, on a grade of 4½ in. per foot, extend across the pits and form a V, in plan, so that each pit is served by both runways, and the apex, at the high point, is over a concrete ash bin of 220 cu.yd. capacity. On each runway travels a trolley with hoisting cable, the cables being led to two separate hoisting plants, each having a 22-hp. motor. A locomotive standing at any part of the pit has its ashes dropped into a pit car, which is then run by hand under one or other of the runways, so that the bail on the fall line of the trolley can be hooked to trunnions on the ends of the car body. The body is then hoisted out of the pit car and hauled to the

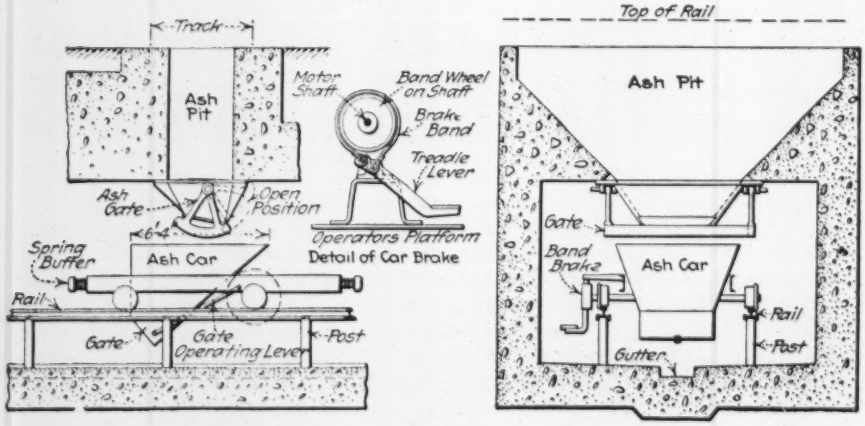


FIG. 5. ASH CAR IN TUNNEL UNDER ASH PIT

top of the runway, where it is inverted automatically by means of a trip and dumps its contents into the bin. The empty body is then run back and lowered upon the car frame in the pit.

Each runway is supported by two-post bents and a tower or four-post bent, the apex of the two runways being carried by a short six-post tower on top of the ash bin. Four lines of laced I-beams are used in each runway, the two inner beams having bolted to their top flanges the 20-lb. rails for the trolley carriage. At each end of the inclined track stops are placed to limit the travel of the trolley. The upper end of each runway is equipped with a slow-down switch, a stop switch and a limit safety switch.

Rectangular concrete piers with footings in the solid clay support the legs of the steel bents and the concrete columns carrying the elevated ash bin. This bin spans the sand track, so that cars which have delivered sand can be loaded with ashes for removal.

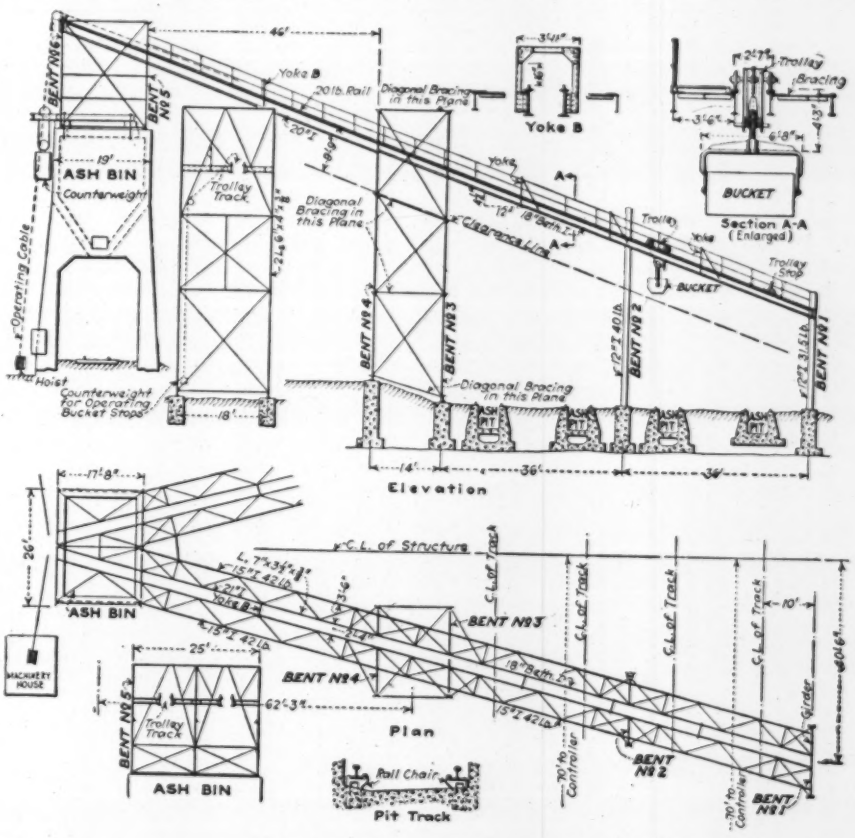


FIG. 7. ASH-HANDLING PLANT AT HASELTON, OHIO; P. & L. E. R.R.

From 100 to 150 engines are handled daily through this plant. Two or three men to handle the ash cars and to attach and detach the hoisting bails are required on each eight-hour shift, the number varying with the number of engines and with the weather conditions. The men operate the ash hoist by means of controllers placed just beyond the ends of the ashpits, from which position the operator can see the ash bucket for the full length of its travel. The men cool the ashes in the cars by means of water from a hose, there being eight separate hose outlets for this purpose.

Cost and Comparison.—These two ash handling plants of the Pittsburgh & Lake Erie R.R. were designed and installed under the direction of A. R. Raymer, chief engineer, and L. H. Turner, superintendent of motive power. The cost of the Brightwood plant was about $96,000, covering the ash hoppers, tunnel, tunnel car, hoist, bin and operating machinery. The cost of the Haselton plant was approximately $91,000, covering the ashpits, pit cars, runway, bin and operating machinery.

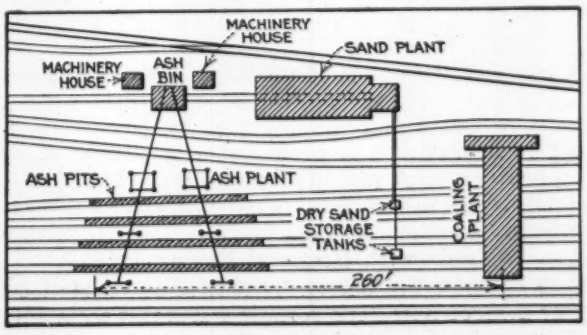


FIG. 6. COAL AND ASH-HANDLING PLANTS AT HASELTON, OHIO

An overhead ash removal system for through train service was used at Groveton, Pa., for about fifteen years, but when the new plant was built at Brightwood the underground system was adopted as it could be operated without endangering or being endangered by the through trains. Underground systems in general, however, are considered undesirable on account of high cost and unpleasant working conditions. At Brightwood, the engines (of through trains) are operated by their crews, but at Haselton, the engines are operated by the hostlers, the road crews quitting on arrival at the terminal. Comparison of operating costs of the two systems cannot be made owing to the different operating conditions. At Brightwood it is essential that trains shall be delayed as little as possible, so that a much larger number of cleaners is required than at Haselton, which is a terminal point and where, in general, it is not necessary to do the work so quickly. Therefore cost per engine is greater at Brightwood.

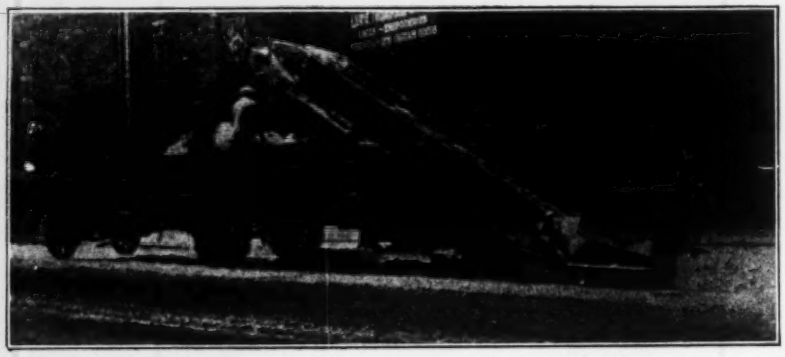
City-Owned Utility Bonds Outside Debt Limit

Besides making it possible for St. Louis and Kansas City, Mo., to increase their bond limit from 5 to 10 per cent the state constitutional amendment adopted last November provides that bonds issued for municipally owned utilities may be secured by mortgages on the utilities in which case the bonds will fall outside the debt limit.

Snow-Loading Machine for Clearing Chicago Streets

A NEW snow-loading machine for clearing streets, which has been purchased by the city of Chicago, is of the conveyor type, scooping up the snow and discharging it into motor trucks, as shown in the accompanying view. An inclined adjustable boom 20 ft. long fitted with high sides to form a trough, is mounted on a frame carried by a caterpillar. Upon the boom travels a 32-in. conveyor belt fitted with transverse cleats, the belt and caterpillar being driven by a 25-hp. gasoline engine. At the lower end of the boom is a plow with a bottom plate or apron 6 ft. wide and having high side wings to guide the snow to the belt. At the upper end is a chute for loading the trucks.

As the machine advances, the snow for a width of 6 ft. is gathered into the scoop and carried up by the conveyor to be discharged into the rear of a motor truck which is backed up to the machine and follows it until loaded. The truck thus moves in the cleared path. This machine, which weighs about 4½ tons, was designed and built by the Barber-Greene Co., Aurora, Ill.



SNOW-LOADING MACHINE FOR CLEARING STREETS AT CHICAGO

Successful operation of the machine is reported by W. J. Galligan, assistant superintedent of streets, who is in charge of street cleaning. On Dec. 26-27, the machine was in service for 32 hours, except at meal times and for one minor repair. It continued in intermittent operation during the next two days. Four men were required, an operator and helper and two laborers, the main work of these last being to clear and trim the snow as it feeds into the plow. Both slush and hard frozen snow were handled, the temperature ranging from — 5 to + 32 deg. F., but the machine appeared to operate equally well with snow of all kinds and on wood, granite, bitulithic and cobblestone paving.

A saving of $450 in labor per 8-hr. shift is reported, as compared with shoveling piled snow into trucks. The plan is to plow the snow into a windrow along the curb, the machine then loading from this windrow into the trucks, thus avoiding the necessity of shoveling the snow into piles for loading by hand. Further, the machine can be operated night and day, thus eliminating the difficulties of organizing shovel gangs for night work in bad weather. The machine will load an 8-yd. truck in 2½ minutes, but a gang of six shovelers will take twenty minutes for the same work. The cost of operating the machine is given by Mr. Galligan as less than $30 per 8-hr. shift, exclusive of interest and depreciation. It consumes about a gallon of gasoline per hour and a quart of lubricating oil per shift.

City Planning Recommendations for Lake Charles, La.

A GENERAL program for improvements to the city plan of Lake Charles, La., has been submitted to J. A. Trotti, mayor, and other city commissioners of Lake Charles, and to a special advisory committee of the Lake Charles Association of Commerce, by Bartlett & Rammey, engineers of San Antonio, Tex. Some features of the plan have been approved by the advisory council for immediate execution and the entire scheme is recommended for careful consideration. The advisory council also endorses the engineers' recommendation for a city plan commission.

The engineers advise enlarging the city by annexation so as to give it control of developments in outlying territory and also throw "more of the burden of the improvement of the community on the close-in lands, which will enjoy a greater percentage of enhancement in values than property within the present city." Enlarged wharfage facilities, with adequate railway service, are considered of prime importance to Lake Charles in view of its expected development "as a port for seagoing vessels."

Besides the creation of a port zone the engineers recommend the establishment of certain areas of the city as wholesale, industrial and unrestricted residence districts. The site for a union passenger terminal, elimination of certain grade crossings and also the elimination of certain railway trackage, the latter to reclaim lake front and other areas from further industrial use, are suggested. The engineers propose three diagonal thoroughfares and the widening of a number of streets.

Most of the street widening, the report states, would be "of direct benefit and value to the abutting and adjacent property owners far in excess of the worth of the narrow strips given up." The engineers go on to say: "Even where the street line is established as much as 25 ft. back upon the present private property, this loss of depth cannot be considered on the basis of front values and reduces the value no more than if taken from the backs of the lots. Offsetting the loss in lot depth is the great enhancement in frontage value from the improved street width."

Other recommendations deal with parks, boulevards, a civic center, sewerage and garbage disposal. A special report on sanitary and storm sewers, with cost estimates, has been made. As to garbage disposal, the report says: "In view of the large areas of adjacent marsh land where garbage can be disposed of without nuisance and with resulting beneficial grade raising, our recommendation is against the installation of an expensive modern garbage incinerator." Light automobile trucks with trailers are recommended for garbage collection.

Trade with Germany During 1920

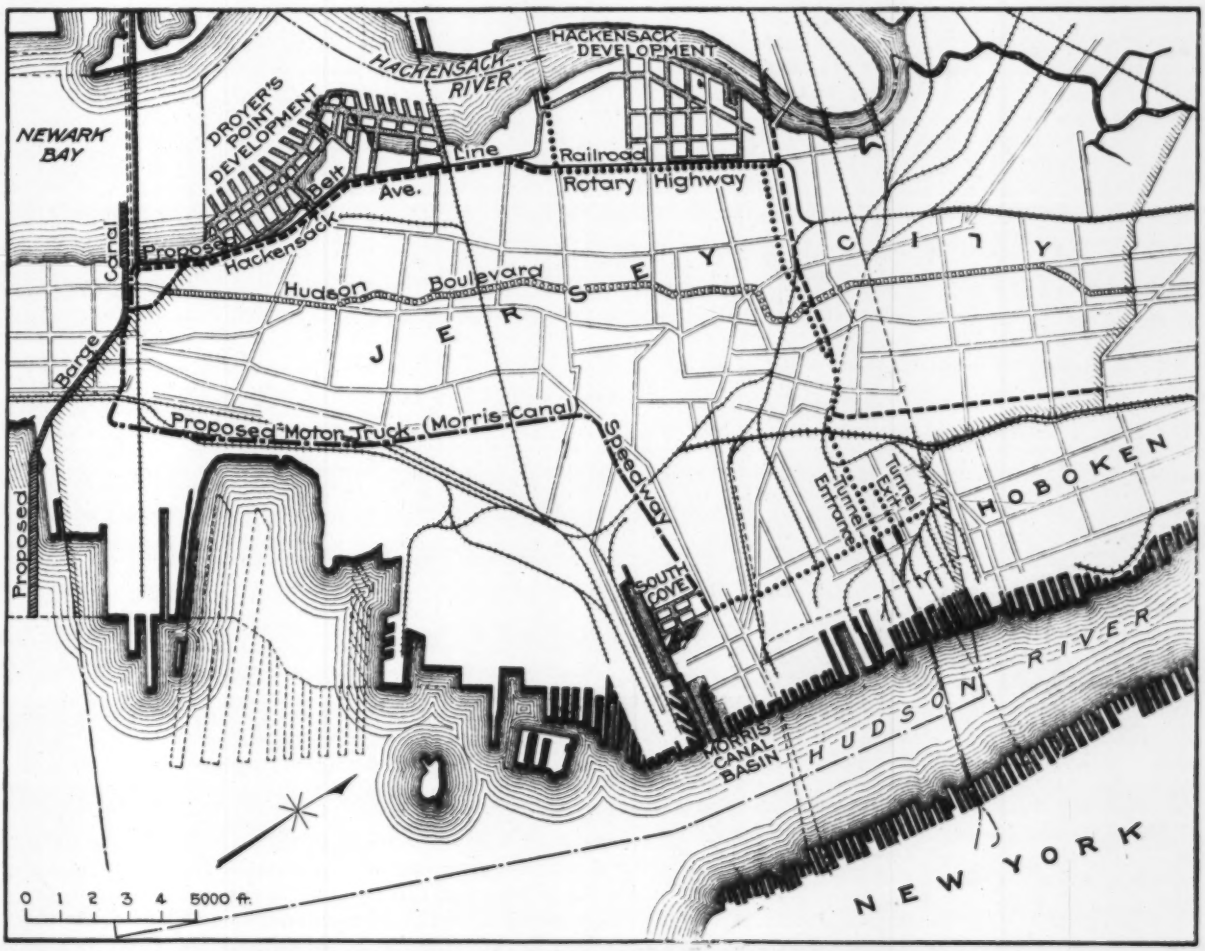
The *Foreign Trade Record*, published by the National City Bank of New York, recently stated that trade with Germany by the United States during 1920 aggregated $400,000,000, as against $533,000,000, the biggest year preceding the war.

Engineer Board Recommends Plans for Jersey City

New Developments Comprise Port Terminals on Hudson and Hackensack and Motor Road Approaches for Highway Tunnel

NINE months ago the City Commission of Jersey City, N. J., appointed a Board of Engineers to study and report on various engineering problems of the city. This board has been working on a number of different problems, including a new street system, sewage disposal, garbage and ash removal, parks and playgrounds, housing and zoning, passenger transportation, etc., and its first report is about to be published. It has paid particular attention to the water-front development of the city in relation to the whole problem of handling freight in the port of New York, and in this connection has made some recommendations that are being taken up by the city authorities actively. These comprise the development of a new industrial port terminal district on Newark Bay and the Hackensack River, the prospective construction of a belt line railway connecting the various trunk lines entering the city, and the laying out of highways which are intended to take care of the increased motor and other traffic from the new highway tunnels now under construction under the Hudson River. The details of the plans given below are taken from the report by Philip Guise, secretary of the board.

The report calls attention to the congestion in the port of New York today and refers to some of the proposed recommendations for improvement of conditions. It concludes that the logical first step in the solution of the problem of expanding New York harbor is in the development of Newark Bay and its adjacent industrial area. As a part of this it commends the exterior belt line railroad which has been proposed to intercept all the western trunk lines somewhere near the outer limits of the New Jersey portion of the metropolitan district, but it says that the realization of this plan will necessarily involve a long period of time and the expenditure of very large sums of money. The board therefore recommends that a quick and effective result can be obtained by unification and expansion of the existing break-up and classification yards facilities in the Hackensack Meadows, amplifying these existing facilities by connecting them together with short belt or marginal railways and extending these facilities at some future time by way of a Hudson bridge and tunnels with a New York City marginal railway which will tie up all of the Manhattan and Brooklyn piers. This part of the report reads as follows:



PROPOSED IMPROVEMENTS OF HARBOR AND MAIN LINE HIGHWAYS, JERSEY CITY

By connecting the existing Croxton yard of the Erie R.R. with the existing Secaucus yard of the D., L. & W.

R.R. and connecting thereto the lines of the New York, Ontario & Western and West Shore Railroads, 50 per cent of the freight of the port can be handled at Croxton. A similar union yard established by consolidating the Pennsylvania, Lehigh Valley, and Oak Island yards, connecting thereto the Central Railroad of New Jersey and the B. & O., will accommodate the other 50 per cent of the business of the port.

Marginal railroads connecting these two yards forming a complete belt line would result. This in effect will accomplish the same result as the exterior belt line, at much lower cost, a great saving of time and is reasonably within the possibility of realization by joint action of the railroads and a state or bi-state body. The existing yards can be readily connected and the Jersey City belt line forming a part of such a connection is already under way.

This proposed belt line railway utilizes the existing New Jersey Junction R.R., which extends along the western shore of the Hudson from Bergen Point to Weehawken, connecting with various roads. It would also use the Lehigh Valley's connection (known as National Docks Ry.), which extends to the Pennsylvania

LAYOUT OF NEW CLASSIFICATION YARDS AND CONNECTING RAILWAYS

R.R. and the New Jersey Junction R.R. There remains then to be built only one side of a four-sided belt, that is a section extending from the Lehigh Valley-Pennsylvania R.R. bridge over Newark Bay, near the Bayonne city line, along Newark Bay and the Hackensack River, crossing the Lincoln Highway by an overhead bridge, and extending across West Side Park on an elevated structure, again coming to grade near the Pennsylvania R.R., which will cross it by an overhead bridge. Connections would be made with Droyer's Point, where an extensive railroad yard is planned, and with the proposed Hackensack River development where yard facilities and provisions for sidings are made. Connections would also be made with all railroads entering the city and also between the yards.

It is the idea of the board that in the yards which would be tied to this line can be classified and separated the commodities whose ultimate and final destination is Manhattan or other parts of New York for transfer to union lighterage or steamship terminals located along the Hudson River shores, but a more important part of their conclusion is that freight for transatlantic or other ocean shipment is to be conveyed directly to and from railroad, warehouse, or steamship terminals located along Newark Bay, the Hackensack and the Passaic Rivers; that is, the board would transfer ocean freight terminals handling that portion of the freight which is not intended for New York City's use from New York to the Newark Bay district, thus eliminating the lighterage charges and congestion now existing.

To take care of the large amount of east-bound and west-bound freight going to and originating in Manhattan Island and Long Island the report indorses the well-known Lindenthal plan of a Hudson bridge and marginal railroads. The text of the report is as follows:

The effective means of accomplishing the transfer across the river is of the greatest importance in the development of the outlying boroughs of the City of New York. This means of transfer across the river should therefore be accomplished not by a temporary makeshift but by a method or means lending itself to full expansion to cover the needs of the constantly growing volume of manufacturers of the City of New York, including Brooklyn, Queens, the Bronx. Jamaica Bay looming up here as the future free port.

The logical accomplishment of this function of the railroad plan is by means of a Hudson River Bridge with marginal railroad extensions; first along the west waterfront of Manhattan, thence extended and carried to Brooklyn by a tunnel near the Battery running along the entire waterfront of the Borough of Brooklyn, extending southerly to the Pennsylvania Railroad yards at Bay Ridge and eventually connecting the Long Island Railroad, the New York Connecting Railroad and Jamaica Bay. This marginal elevated railroad to serve modern piers to be erected along the Hudson River shore of Manhattan by direct track connections to the upper deck of these piers whence the commodities can be loaded or unloaded to and from the ship by modern handling appliances, cranes, telfers, tractor-trailers, etc. The lower decks of the piers and the street surface reserved for motor truck and trailer operation.

The first step proposed by the Jersey City plan, the connecting up of the existing railroad yards at Croxton and Oak Island and their articulation by short belt lines to facilitate unified operation is also the necessary first step in bringing the trunk line railroad service across the proposed bridge. In these yards would be prepared the daily shipments on call to and from New York City, that freight not destined for Manhattan going or coming in via Newark Bay.

WEST WATER-FRONT IMPROVEMENTS

The west water front of Jersey City is divided geographicaly into two parts—that portion extending from Bayonne to Newark, including Droyer's point, and the portion to the north of this extending along the Hackensack River from West Side Park to the Pennsylvania R.R. main line. All this is in the Newark Bay district where there is at present a 20-ft. channel and where the government has under consideration the deepening to 30 ft. Already on the north side of the bay the city of Newark is developing its Port Newark terminal where the Submarine Boat Co. has its shipyard. Opposite this Port Newark development Jersey City is developing the so-called Droyer's Point district. Here the plan is somewhat tentative, particularly as regards the lengths and widths of the piers. The general development consists essentially of the reclamation of land under water comprised between the bulkhead line, the Morris Canal, the Bayonne city line, and the Newark branch of the Central Railroad of New Jersey. The entire area included between these lines, aggregating about 350 acres, is to be reclaimed by hydraulic dredging and filling and a bulkhead built to provide wharfage for vessels of all types until such time as the necessity for pier space

develops. The present plan shows an ultimate development of sixteen piers, 150 to 250 ft. or more wide and from 500 to 1,000 ft. or more long. The city is now working on the dredging and filling here under an appropriation of $650,000. This district is on deep water which some time in the near future will be deep enough for all necessary purposes and is within 45 min. by motor truck from the Manhattan terminal of the Hudson tunnels.

The proposed Hackensack River improvement consists of the same type of development, which is visualized as a wharfage and warehouse district under the ownership or control of the city. A street system has been placed on the map for this district, but no work has been undertaken, though condemnation proceedings are under way. It would cost as outlined about $3,500,000.

The major part of the Hudson River waterfront of Jersey City being occupied by the railroad yards of the trunk lines, waterfront plans on the Hudson River are confined at this time to development of the Morris Canal Basin where a marine terminal is planned with two piers 1820 x 250 ft. with warehouse and adjacent terminal development. Just west of this in the South Cove a Barge Canal and terminal basin is planned with one 550-ft. double-deck pier. This is about to be begun by the city at an estimated cost of $700,000.

Proposed Highways

The highways which are proposed are two routes to take care of the expected traffic from the New Jersey end of the new highway tunnels under the Hudson. The first highway to be built will be called the Rotary Highway and will extend west from the tunnel portal, partly in widened old streets and partly in new right-of-way, up over the Palisades on a new viaduct and connecting with the Lincoln Highway to the west. The other recommendation is that the Morris Canal bed be utilized for the construction of a modern highway for the operation of motor trucks at high speed. By widening Henderson St., which parallels the Hudson River at the portal of the tunnel, a broad boulevard completely protected beyond the Henderson St. district could be had from the tunnel to Newark Bay, which would be crossed by the proposed inter-county vehicular railroad bridge. Besides the highway and the speedway several other routes as indicated on the map are proposed.

The final recommendation is that a barge canal be cut through the Bayonne peninsula between the Hudson and Newark Bay. This would add to the convenience of operating the Newark Bay district and place Newark Bay within the free lighterage limits.

The Board of Engineers which was appointed by the City Council of Jersey City is composed of engineers in different lines of work in the city, county and state, all of them, except the secretary, serving without pay. They are: Chairman, Martin Schreiber, who is engineer of the west water front committee of the Chamber of Commerce; Thomas J. Wasser, state highway engineer of New Jersey; Charles van Keuren, chief engineer, Department of Streets and Public Improvements of Jersey City; Joseph P. McLean, engineer, Hudson County Tax Board; Frederick Dunham, harbor engineer, Jersey City; Hugh A. Kelly, engineer, Department of Parks, Jersey City; Albert De Castro, engineer, Chamber of Commerce of Jersey City. Philip Guise is the secretary of the board and in charge of the engineering and other organization.

Future Water-Supply Needs of the Metropolitan District

Rates of Filtration Have Been Doubled Maintaining Efficient Bacterial Removal and Reducing Unit Costs

Conclusion of Discussion Before the New York Section of the American Society of Civil Engineers on Water Supply and Sanitation in the Metropolitan District.

HOW MUCH WATER the New York and New Jersey Metropolitan District will need twenty-five to fifty years hence, the available sources in New York, New Jersey, Pennsylvania, Connecticut and Massachusetts and the possibilities of joint action to meet those needs were some of the topics discussed on Jan. 13 before the New York Section of the American Society of Civil Engineers. The general subject for the meeting was Water Supply and Sanitation in the Metropolitan District. The portion of the discussion dealing with sewage and garbage disposal and snow removal, with particular reference to New York City, was abstracted at length in *Engineering News-Record*, Jan. 20, p. 104. Various phases of the water-supply question were presented at the meeting by W. W. Brush, deputy chief engineer, Department of Gas, Water Supply and Electricity, New York City; J. Waldo Smith, chief engineer, Board of Water Supply of New York City; Morris Sherrerd, chief engineer, Department of Streets and Public Improvements, Newark, N. J.; and William H. Burr and Allen Hazen, consulting engineers, New York City. The consensus of opinion was that water in plenty can be found to meet the future needs of the many millions in the metropolitan district twenty-five to fifty years hence, yet there should be no time lost in beginning to make studies and plans for future enlargement of the supply of the various portions of the district since already consumption is pressing close upon supply, including what will become available by works now under construction for New York City and for Newark. Most of the speakers believe that it would be necessary to go so far afield for water as to give rise to interstate complications unless joint action to prevent them were taken. An abstract of the discussion on water supply follows.—Editor.

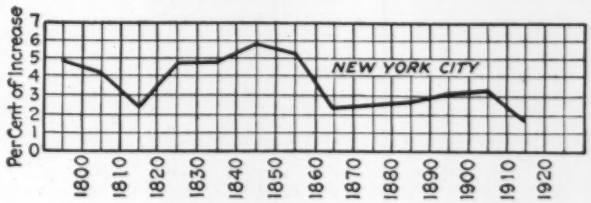


FIG. 1. PERCENTAGE OF ANNUAL POPULATION INCREASE, NEW YORK CITY

The points in the curve at the middle year of each decade indicate the annual compound percentage of increase during the decade.

Data to show the present available supply, present consumption and probable future needs of New York City were presented by Mr. Brush. Taking into account all sources of supply owned by the city, and including the Schoharie watershed addition to the Catskill supply, the safe yield with minimum rainfall totals 1,109 m.g.d., while the amount available with normal rainfall would be 1,280 m.g.d. The amount actually used during 1920 was 690 m.g.d. Besides the amount just stated private companies in Brooklyn and Queens Boroughs supplied 44 m.g.d in

1920, making a total of 734 m.g.d. supplied by the city and by private companies. The Schoharie supply now under development to be added to the Catskill will yield 300 million gallons daily.

Since the Catskill aqueduct was put in use the draft from the Croton drainage area has been materially reduced and the utilization of the supplies on Long Island and on Staten Island has almost ceased in order to do away with pumping so far as possible and take advantage of the gravity Catskill supply.

Speaking of the recurrent newspaper discussions about the large volumes of water wasted over the Croton dam of late, Mr. Brush pointed out that this is due to drawing upon the Catskill, as already noted, and will be greatly reduced when the Croton is utilized to its full capacity. He also pointed out the possibility of using the Croton dam overflow for hydro-electric power, the fall here at full reservoir being 150 ft. At other Croton reservoirs there are differences in water level of 90 ft. that might be used to develop power. It has been estimated that electric power equivalent to at least 3,000 kw. could be advantageously developed in the Croton watershed and that if this power were sold at the cost of only the fuel used to develop electric power within New York City the net return would be about $100,000 a year, equal to about 35 per cent on the capital investment.

The population increase of New York City by decades is shown by Fig. 1, while Fig. 2 shows the yearly percentages of increase in total water consumption for the past twenty years, also for the entire city. The average yearly increase in consumption during the entire twenty years was 3.2 per cent.

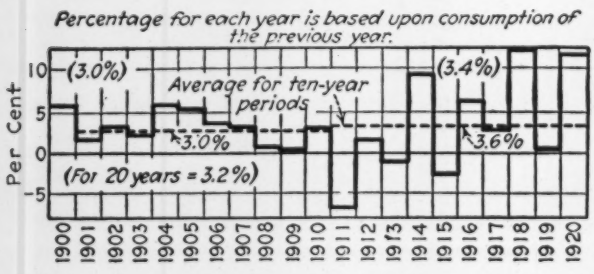


FIG. 2. YEARLY PERCENTAGE OF ANNUAL INCREASE IN WATER CONSUMPTION OF NEW YORK CITY

The percentage for each year is based upon the consumption of the previous year.

Fig. 3 shows the total water consumption and population in New York City from 1895 to 1920, and forecasts of population to 1945 and of consumption to the same date, the latter being based (1) on the assumption that the increase in consumption will be 3 per cent a year and (2) that it will be 4 per cent. The accompanying table shows the water consumption by boroughs for the entire city from 1900 to 1920. Waste prevention work from time to time has materially reduced the per capita consumption.

The entire safe supply of 1,109,000 gal. a day, Mr. Brush stated, might be required as early as 1932, or possibly not until 1941, while the average between the two extremes would be 1936. It is to be noted that a 3 per cent rate of increase in consumption after 1920 is based on the inspection at least once a year of all plumbing fixtures in unmetered premises.

Finally Mr. Brush said: "The engineers of the Bureau of Water Supply of the city believe that the time has now come for the initiation of the work of developing the supply which will be required about fifteen years hence."

In his discussion Mr. Smith said that on the completion of the Schoharie development of the Catskill area about 1925 New York City would have sources of water supply giving a safe yield of about 1,136 m.g.d. From this some 50 m.g.d. would soon have to be deducted on account of the unsatisfactory quality of the water, leaving about 1,086 m.g.d. available. Assuming that the normal increase in per capita consumption stopped at the present 131 gal. a day and that the growth of population is the least that

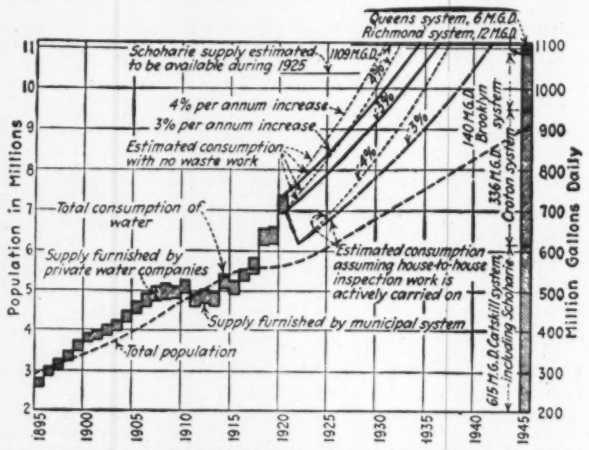


FIG. 3. POPULATION AND WATER CONSUMPTION IN NEW YORK CITY FROM 1895 TO 1920, WITH FORECASTS OF FUTURE POUPLATION AND CONSUMPTION

The forecasts of water consumption at the rates of increase indicated are designed to show when, at those rates, the present available supply completed or under development would be exhausted. To hold the yearly increase of water consumption to 3 per cent a year it would be necessary to inspect all plumbing fixtures in unmetered premises once each year.

can reasonably be expected the consumption would exceed the safe yield in 1938, whereas if the consumption continued to increase at the rate of the last five years it would exceed the safe yield in 1929. In the metropolitan area of northeastern New Jersey consumption already equals or exceeds the safe capacity of the present works, while Westchester County municipalities in New York State have reached the limit of their present water resources. The only important available source for an additional water supply in northeastern New Jersey is the further development of the Passaic watershed, but that with other local sources can probably be made to serve for fifteen to twenty years, although full development would require the construction of works across the state line in New York. It therefore appears that in fifteen years more or less "the entire metropolitan district in New York and New Jersey, with a probable population of 12,000,000 to 14,000,000, will have reached the limit of its water resources."

The conditions for developing more water from the Catskill area, beyond what is already under way, are not favorable. Possible sources of Dutchess and Columbia Counties, east of the Hudson, are barred to New York City by state legislation and if available would yield only about 250,000,000 gal. Another 250,000,000 gal. could be obtained from the deep sands of Suffolk County, on Long Island, but this source is also barred by the State Legislature. If made available by the legislature it would have to be pumped.

A gravity supply of 1,000 m.g.d. could be developed in the Adirondacks, but at a distance of 175 miles and at a cost that would be prohibitive except as a last resort on account of the great length of aqueduct and the water-power interests that would have to be taken care of by providing compensation water from additional storage reservoirs.

Some 750 to 800 m.g.d. could be brought a distance of only some 60 miles from the Ten Mile and Housatonic rivers, but this drainage area lies in the three states of New York, Massachusetts and Connecticut, and water-power rights would be involved.

A supply of 1,000 to 2,000 m.g.d. from the Delaware, only some 60 miles distant, could be developed, but local conditions are unfavorable to the construction of large storage reservoirs, and besides building many small reservoirs for water supply a storage would also have to be provided to compensate existing water supply, power and other interests.

Finally, Mr. Smith stated that since the available water supplies of all parts of the New York and New Jersey Metropolitan District would be exhausted at about the same date—i.e., what may be called local sources—it is apparent that water must be brought from great distances and at such costs as to make supply works prohibitive for the smaller communities acting alone. One supply for the whole metro-

politan district would therefore be logical. "Barring interstate complications," Mr. Smith said, "the Delaware lends itself particularly well to such a comprehensive treatment of this problem since, according to the method of development, an aqueduct to the City of New York will naturally either skirt or cross the north Jersey metropolitan area. With the City of New York amply supplied from the Delaware River Westchester County could be supplied by the existing Croton and Catskill works until such time as it will become possible and necessary to develop one of the sources to the north."

Mr. Sherrerd stated that the immediate present needs of the two million inhabitants in the New Jersey portion of the metropolitan district could be met by water available within the borders of New Jersey, especially if possibilities in south Jersey were utilized, although the latter would require pumping.

The population in the New Jersey territory is increasing at the rate of about 4 per cent a year and the water consumption is increasing somewhat faster than the population. Within the past twenty years water consumption in Newark has doubled, notwithstanding the fact that the supply of Newark is now 98 per cent metered. As an addition to its present supply of 50 m.g.d. from the Pequannock River there is now being developed for Newark an equal amount by the North Jersey District Water Supply Commisssion from the Wanaque River — which like the Pequannock River is a highland branch of the Passaic. An additional 40 m.g.d. of water could be developed from the Lower Passaic. The Hackensack River is good for some 50 m.g.d. total. Other supplies in the New Jersey metropolitan district, chiefly groundwater, yield some 20 to 25 m.g.d., bringing the total supply probably available within the next five to ten years up to 250 million gallons a day.

AVERAGE DAILY PER CAPITA CONSUMPTION OF WATER IN NEW YORK CITY FOR THE YEARS 1900 TO 1920

	Manhattan and Bronx	Brooklyn	Queens	Richmond	Total	
1900	131	85	115	100	114	1900
1901	129	84	116	100	113	1901
1902	129	84	110	100	112	1902
1903	127	85	115	99	112	1903
1904	129	90	121	100	115	1904
1905	132	93	120	100	118	1905
1906	132	97	120	98	119	1906
1907	130	100	124	102	119	1907
1908	125	101	121	99	116	1908
1909	120	95	112	106	111	1909
1910	119	97	106	104	110	1910
1911	105	92	105	109	100	1911
1912	104	91	109	114	100	1912
1913	105	79	101	127	96	1913
1914	113	82	105	125	102	1914
1915	109	76	92	121	97	1915
1916	114	78	102	129	101	1916
1917	114	78	115	125	102	1917
1918	123	90	117	162	112	1918
1919	121	87	108	163	110	1919
1920*	155	99	104	159	131	1920

* Based on 1920 Federal Census.

Within twenty-five years, Mr. Sherrerd estimates, 500 m.g.d. will be used for metropolitan New Jersey and in fifty years 1,000 m.g.d. The latter amount, Mr. Sherrerd said, "will scarcely be available within the confines of New Jersey, at least within reasonable distance of the centers of the population to be supplied."

All the foregoing statements being taken into consideration, and in view of the impracticability of the proposition to create a metropolitan state, Mr. Sherrerd was of the opinion that reciprocity between Pennsylvania, New Jersey, New York and Connecticut is inevitable if the water-supply problem of the metropolitan district is to be solved. A joint commission for that purpose was suggested, although Mr. Sherrerd added that "the experience of the New York and New Jersey Port and Harbor Development Commission does not argue well for united action."

Mr. Burr prefaced his remarks by the assertion that the preventable waste of water in New York City is small and that the average per capita water consumption is one of the lowest in the country. The gist of his further remarks was in favor of the ultimate adoption of the alternative plan of the New York Commission on Additional Water Supply, presented in 1903, which outlined the possibility of a filtered and pumped supply from the Hudson River at a point not far from Kingston, where brackish water would for the most part be avoided. The pumping cost would be partly offset by the relatively short aqueduct as compared with bringing in a far distant gravity supply, say from the Adirondacks. Water might be stored in the Adirondacks for the primary purpose of water power, and then be picked up at the proposed water-works intake on the Hudson near Kingston. This would require regulation or balancing so the water would be used for power when needed for the supply of New York City. Apparently this plan is for the rather distant future, since Mr. Burr stated that he was inclined to think that after present sources, and possibly the Delaware River, were exhausted, the Adirondacks would prove to be a valuable source of supply.

Allen Hazen took an optimistic view of the water-supply problem (as he did in his remarks on the sewage-disposal problem noted in our issue of Jan. 20, p. 104). Briefly, he said there is no cause to worry about the future water of the district since it has a rainfall twice what is needed for agricultural purposes, coming mostly in winter. If there were a market for it, Mr. Hazen said, there could be provided ten times the water that will actually be demanded in the territory from Boston to Washington. As to the Westchester County communities (north of New York City) Mr. Hazen said that if they could only get together a water-supply plan could be devised that would give them water cheaper than its cost to the metropolitan district.

Water and Sewerage Systems Not Fully Used

A recent sanitary survey of Hamilton, Ohio, disclosed the fact that one-seventh of the population did not use the public water supply, although the entire population had access to the city mains. The inquiry involved 757 representative households scattered throughout the city. In 85 per cent of the homes the public supply was used, in 12 per cent, private wells and in 3 per cent, cisterns. Thus the net value of the public supply from the health standpoint was reduced 15 per cent. The results of the inquiry concerning sewerage are even more startling. Of 775 households only 55 per cent had connections to the sewers and the remainder had outdoor privies. The city is well sewered on a separate plan, the sanitary sewers covering 88 per cent of the area of the city. Of the households having privies 75 per cent were accessible to sewers. W. H. Dittoe, chief engineer, Ohio State Board of Health, who conducted the survey, states that Hamilton may be an extreme case but he is of the opinion that is is representative of cities of its class. He recommends further surveys and greater activity in requiring the inhabitants to utilize their public water and sanitary facilities.

Wisconsin Begins Snow Survey

On selected main highways in Wisconsin records are being kept this winter of the character and extent of snow movement by the wind; of drift formation, location and magnitude, and all similar facts in connection with the accumulation of snow on these roads. Reports will be made on simple forms, which, in addition to the snow data, call for suggestions as to means of prevention of drifts by wind breaks, fences, hedges, etc. It is believed that with such records, plans may be formulated for barriers and other drift preventives which will materially reduce obstruction of highways. While the surveys are being conducted by country highway commissions, the routes surveyed are selected by the state highway commission, J. T. Donaghey, maintenance engineer.

Belt Line Plan to Make New York A Railhead Port

Joint Harbor Commission Also Projects "Automatic-Electric" Underground Loops for Manhattan Distribution

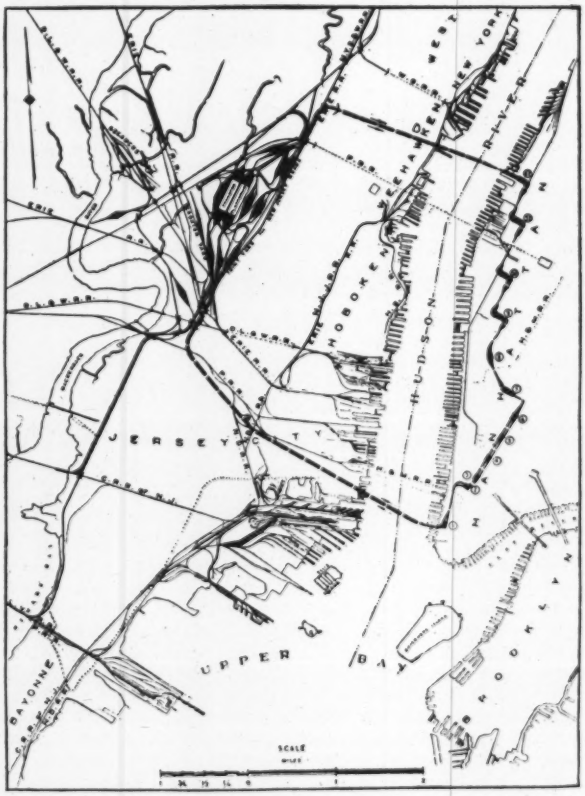
A SYSTEM of outer and inner belt lines to bring direct rail connections to the greater part of the water front of New York Harbor and a plan for building an underground "automatic-electric" freight subway loop system for distribution on Manhattan Island (at an estimated cost of $200,000,000) are the principal features of the physical plan for the solution of the New York port problem proposed in the report of the New York-New Jersey Port and Harbor Development Commission addressed to the governors of the two states, Dec. 16, 1920, and made public Jan. 24, 1921. While recommending the belt line system and the underground "automatic-electric" distributing system as the principal plans for ultimate relief, the commission makes reference to "measures for immediate relief" as "voluntary store-door delivery" by direct run of motor trucks with detachable bodies from rail heads to store doors in New York City and the unification and joint operation of marine equipment.

While the commission urges that these measures for immediate relief "be adopted at once," it does not at this time issue the two chapters of the detailed report on "Special Motor-Truck Service for Handling General Package Freight Between New Jersey and Manhattan" and on "Railroad Belt Lines and Consolidated Marine Service"—Nos. 12 and 16, respectively. The chapters of the report now issued, Nos. 9, 10, 11 and 14, deal with plans that the commission has rejected—the proposals for an elevated standard equipment railroad on the west side of Manhattan, an underground standard equipment railroad, and the marginal railroad with bridge connection—as well as the recommended automatic-electric system plan for Manhattan. As noted below, the commission finds that the cost per ton of handling freight by standard gage railroad—plans for which were rejected—would exceed *present* costs.

The commission holds the port to extend from Jamaica Bay to Newark and from Perth Amboy to Irvington-on-the-Hudson, and believes that a system of inner and outer belt line railroads connecting all trunk lines and having numerous spurs to the various water fronts, to be developed "in such sequence as further study would determine," would provide best for the future growth and economic development of the port.

While practically every part of the port, except Manhattan, would have direct rail connection with the water front, without breaking of bulk, the commission finds that a standard railroad in Manhattan is not feasible and therefore proposes an underground "automatic-electric system," an entirely new form of conveyor railroad, built below two subway levels, which, serving the nine New Jersey trunk lines as well as the New York roads, will carry freight on short trains with special cars, moving without locomotives or train operators, and running between twelve distributing terminal points in Manhattan and the joint yards in New Jersey and toward the upper end of Manhattan Island.

The first stage of the "automatic-electric" development in Manhattan is indicated in the accompanying cut. It provides for linking the New York Central R.R. with the New Jersey railroads through a loop from a joint yard in New Jersey and a spur to the New York Central's 60th St. yard, to "do away with the surface tracks in 10th and 11th Aves." and provide equal service for each of the ten railroads at twelve union terminals in lower Manhattan. The second stage, bringing the New Haven and Long Island Railroads into the system through a second joint yard near Wards and Randalls Islands, which the New York Central R.R. will also reach by additional tracks along the Harlem River, and providing additional lines and stations in upper Manhattan, "will solve the New York Central-Riverside Park problem by making possible the complete removal



FIRST STAGE OF "AUTOMATIC ELECTRIC" SYSTEM
Connection to N. Y. Central Lines Made Later

of the tracks from 60th St. yard to Spuyten Duyvil, and will give all parts of Manhattan universal rail service."

The accompanying cross-sectional drawing shows a typical "automatic-electric" distributing terminal in Manhattan, as proposed by the commission. The purpose of the plan is to release the present railroad pier stations for steamship service and the marginal way for supporting warehouses and to eliminate the present congestion of trucks on West St. and the marginal way, as well as to provide union terminals nearer to consignees and shippers, and reduce trucking haul and street congestion in Manhattan. The proposed facilities are expected materially to reduce car-float and railroad lighterage service, but much will still remain which the commission would consolidate into joint operation from a few new railroad terminals on the water front.

Coal for Manhattan would be handled by barge and lighter as at present. It was not found feasible to provide for handling coal by the automatic system.

The commission regards the proposed railroad-terminal system as the backbone of a rational port development, and it constitutes the physical plan which, together with a compact between the two states to make it effective, the commission urges for formal adoption. In furtherance of that rational development, though not as a part of the official plan, the commission recommends the following:

Construction of food receiving stations and inauguration of a system of inspection and certification at the railroad joint yards, which would make possible the creation of terminal markets around stations of the automatic-electric systems in Manhattan and the Bronx.

Reorganization with wider piers and slips and more warehouse facilities on the Manhattan and other congested water-fronts.

Dredging of channels to every part of the water-borne commerce seeking to use them, and removal or modification of bridges obstructing the channels.

Provision of suitable highway access to every part of the Port's waterfront.

Construction of additional terminals for the New York Barge Canal.

Wide installation of judiciously selected freight-handling machinery.

Creation of bunker facilities and fuel reserves for steamships.

Erection of grain elevators for joint use of New Jersey railroads and New York barge canal at a southern terminus of the outer belt line and at Piermont, and early completion of the barge canal elevator authorized at Gowanus Bay.

Provision of better facilities for handling building materials.

Zoning of steamship terminals by trade routes as far as practicable.

Establishment of free ports in the Port District.

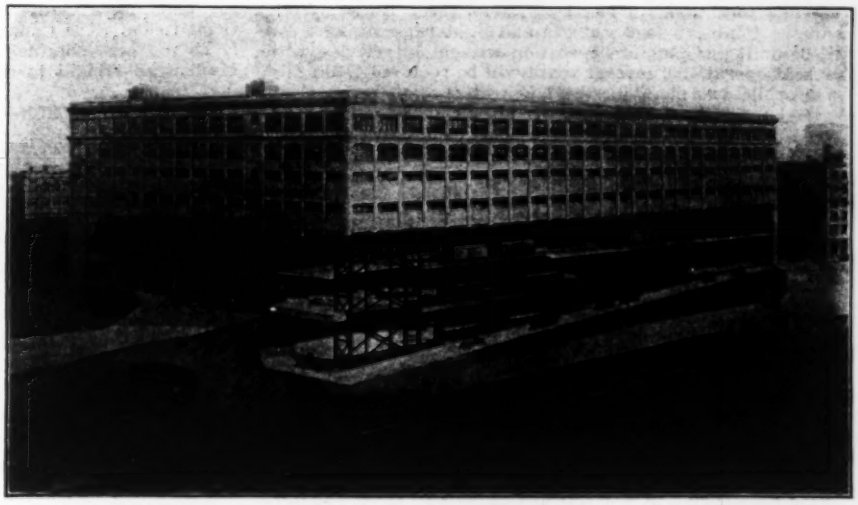
Obtaining of immediate partial relief from present oppressive terminal conditions through:

(a) Consolidation of marine equipment and service; (b) inauguration of voluntary store-door delivery by an organized motor-truck medium.

The "Summary of Joint Report With Comprehensive Plan and Recommendations," which the commission issues at this time (in addition to Chapters 9, 10, 11 and 14 of the joint report), describes the "automatic-electric" system as a joint railroad that taps all of the nine New Jersey railroads and leads to a joint yard on the Hackensack Meadows where incoming freight is transferred at extensive platforms to small trucks and hauled by tractors upon special cars. The cars, operated singly in the yard, would be made up into eight-car trains, dispatched on either of two parallel tracks passing under the Hudson to about 47th St., turning southward below two levels of subways and finally returning to the joint yard by another set of tunnels near the Battery. Twelve terminal distributing points, with manufacturing and warehouse floors above, would be distributed along the route in Manhattan, with approach sidings underground. When a dispatcher at the joint yard throws an electric switch the eight-car train would start automatically; speed up to 13 miles per hour and run to the desired terminal, on the approach siding of which it would automatically come to rest. Return trains would start from forwarding sidings at the terminal, when a switch is thrown, proceed to the joint yard and come to rest. The cars would then proceed singly to the transfer platforms, their trucks bearing outbound freight are removed and they receive new inbound loads and continue in the cycle. Elevators handle individual cars from the "main line level" to the outbound and inbound floors above, where loads are discharged and new loads received.

Surface Belt Lines

The recommended belt-line system includes joint marginal surface belt lines along a large portion of the navigable water fronts of the port, serving steamship terminals or industrial developments. The outer belt line would extend from Piermont above the Palisades to Bayonne, Staten Island and Perth Amboy, passing west of Paterson and the Orange Mountains. Connection between the New York and New Jersey systems is proposed first by car ferry across, and ultimately by tunnel under the Upper Bay. Brooklyn and the East River section of Queens would be served by the Long Island-New York Connection R.R. from Bay Ridge to Hell Gate, and by marginal lines, not necessarily continuous, but reached by float bridges or by spurs from the Bay Ridge-Hell Gate line, from which spurs are to be run to Jamaica Bay and Flushing Bay. Marginal lines would skirt the Harlem and East Rivers in the Bronx from Spuyten Duyvil to Throgs Neck and other lines are virtually to encircle Staten Island. Yonkers and the communities north are to be served by joint car-float stations reached from Piermont. Existing belt lines would be improved to serve the Hudson River and Upper Bay water fronts in New Jersey. New lines along both sides of Newark Bay and the Hackensack River, the west bank of the Arthur Kill and the north bank of the Raritan River are to serve Newark, Jersey City, Bayonne Elizabeth, Perth Amboy and other communities.



SECTIONAL VIEW OF TYPICAL "AUTOMATIC ELECTRIC" TERMINAL

The following figures are presented comparing the standard-equipment railroad with the "automatic-electric" system recommended: Capacity per year, standard equipment, 6,000,000 tons; automatic-electric system, 10,000,000 tons; cost of construction, standard-

equipment, $241,131,000, automatic-electric, $201,190,000; operating cost per ton, standard-equipment, $3.47 (compared with estimated present cost of $2.25 with existing facilities), automatic-electric, $1.82. It is stated that a relatively small expenditure for five additional automatic-electric terminals would bring the capacity of that system to 14,360,000 tons per year. It is estimated that the system will save some $14,000,000 yearly and reduce railroad costs, truck delays and trucking costs, if rentals for terminal storage space be included, besides effecting "many other important benefits not possible to estimate in money values."

Measures for Immediate Relief

Although Chapters 12 and 16, the titles of which are announced as "Special Motor-Truck Service for Handling General Package Freight Between New Jersey and Manhattan" and "Railroad Belt Lines and Consolidated Marine Service," are not issued at this time, the "Summary of Joint Report," now issued, contains the following paragraphs:

While the automatic-electric system, the belt-line system and the joint car-float stations and lighterage stations can all be built and put into operation without interfering with present operations, several years will be required to do this. Meanwhile two steps can be taken at once to bring about partial relief in the face of the growing congestion. One of these is the consolidation of marine equipment, the other is the inauguration of "voluntary store-door delivery."

Consolidation of marine equipment need not await consolidation of terminals at any point. The advantages of a single large fleet of tugs, car floats and lighters in place of a number of independent fleets can be realized immediately.

"Voluntary store-door delivery" offers a still better opportunity for relief. Investigation has shown that probably 30 per cent of the railroad business of Manhattan is in carload lots, and a considerable amount of that of the other sections of the port is in large consignments. The congestion at pier and other freight stations can be materially relieved by bypassing this freight and making pickups and deliveries direct between these large companies and the railroad yards. This will involve what might be termed a "partial or voluntary store-door delivery." A direct motor-truck service would be inaugurated between transfer platforms constructed at the railroad yards and large shippers in Manhattan and elsewhere in the port.

To avoid rehandling of the freight there should be a considerable number of detachable truck bodies with a comparatively small number of chassis, so that goods could be transferred from the car to the truck body at the transfer platform and delivered direct to the consignee. The service should be controlled by some suitable medium between merchant and railroad.

These measures for immediate relief involve no expenditures not utilized in the ultimate plan other than the construction of a few transfer platforms—for the motor-truck chassis, detachable bodies and voluntary store-door delivery should remain as auxiliaries to the automatic-electric stations—and the Commission urges that they be adopted at once.

In commenting upon a demountable-body-motor-truck system for universal freight distribution service, the commission makes the following statement in the summary:

In Cincinnati interchange of railroad freight in trap cars and local rail delivery and collection of freight at suburban stations have been to a considerable extent replaced by motor trucks with detachable bodies, operated on a schedule by a motor-truck company.

It was suggested that the system be applied at the Port of New York. Stations for the transfer of freight between cars and truck bodies, it was stated, could be built at the waterfront terminals of the several railroads, and trucks could operate between these stations and zone terminals at any desired point in Manhattan, or to and from the store doors of establishments large enough to receive and dispatch full truck bodies. It was pointed out also that while the motor truck could at the present time utilize the existing Hudson River ferries, special ferries for this service alone could be installed when the traffic warranted it.

This system has elements to commend it. The Commission is convinced, however, that its logical application at the Port of New York is to secondary rather than primary distribution. The Commission believes that it would be unwise to add this traffic to the existing vehicular traffic on the ferries, even though analysis shows that it might be accommodated; and that it would be unwise to impose this traffic on the streets along the Manhattan waterfront, inasmuch as one of the objectives in the solution of the Manhattan terminal problem is to reduce the truck congestion on the streets. Locating the transfer stations at the waterfront yards of the individual railroads would lessen the opportunity in the future of putting those yards wholly or in part to better uses, a fact which leads to the conclusion that the transfer point for such a system should be on the Hackensack Meadows at a joint yard.

The system shows upon analysis a greater cost per ton for handling freight than the one recommended by the Commission. The Commission cannot therefore recommend it as the best obtainable for the primary distribution of Manhattan freight to and from the New Jersey railroads.

Food Distribution—Pier Widths and Equipment

The Commission believes that the food-distribution problem can be effectively solved by creating food-receiving stations at the joint automatic-electric yards, including dry and cold-storage warehouses, sampling rooms and facilities for reconditioning and grading, and establishing at these stations a system of sampling and certification under public direction. Buyers will then find it necessary to see only the samples at the primary market, and their orders can be filled by direct shipment from the receiving stations, via the automatic-electric system or the belt-line railroads. This the Commission believes will greatly reduce the high cost of living within the port district.

Market structures far better adapted to the business than the old and small buildings of the present market can, and the Commission believes will, be built adjoining automatic-electric terminals; but the change will be by orderly voluntary action of the dealers, and not by forcing them into definitely established quarters.

Reorganization with wider piers and slips and waterfront warehouse facilities as recommended by the commission does not conflict with New York City's newly adopted plan for the lower west side of Manhattan, but extends the principle to frontage not yet covered by the city's plan, and to the opposite New Jersey shore. The Commission does not find the port so deficient in cargo-handling machinery as critics charge, nor does it look upon an abundance of machinery as a cure-all. It is useless, the commission thinks, to speed up one operation if the other operations cannot keep pace, hence tractors and trailers to move the goods on the pier are held to be as important as cranes to transfer them over the ship's side, and neither are of much value if warehouse space is not at hand to relieve the wharf shed of storage duty.

The Commission was created in 1917 by the legislatures of the two states to study the needs of the whole port and to formulate a comprehensive policy. The full report of the two-year investigation, which will be in two volumes and contain several hundred pages, will

be ready in a few weeks, but the Commission has prepared for immediate presentation its advance summary of sixty-five pages, together with four of the supporting chapters bearing on the Manhattan freight problem. The Commission consists of William R. Willcox, chairman; J. Spencer Smith, vice-chairman, and Eugenius H. Outerbridge, DeWitt Van Buskirk, Murray Hulbert and Frank R. Ford. Maj.-Gen. George W. Goethals is consulting engineer, B. F. Cresson, Jr., chief engineer, Julius Henry Cohen, counsel; William Leary, secretary, and C. A. Ruhlmann, assistant secretary.

The Commission urges the creation of a unified port district and a continuing port authority with broad powers and jurisdiction over the entire port district by means of a compact or agreement between the States of New York and New Jersey.

LETTERS TO THE EDITOR

It is the editors' desire to publish here all worthwhile letters pertinent to the interests of engineers and contractors. In order that this may be possible contributors are asked to condense their letters to the shortest space consistent with a clear presentation of their ideas.

Pile Bearing and Soil Pressure

Sir—In reference to the article by Lazarus White in *Engineering News-Record*, Dec. 30, 1920, p. 1268, and the letter from E. G. Haines in the issue of Jan. 13, 1921, p. 89, the writer desires to present some comments.

Considering earth or soil as an elastic solid may be reasonable in *most cases* where its bearing value alone is considered. Where pressure enters as a factor however, this assumption may be misleading except in the case of soils remaining solid under the operation as noted later.

To return to the foundation. The restriction "most cases," above, is made advisedly, because if a pile footing bears in soft clay the clay will flow wherever it ceases to be confined. The only danger to be apprehended is from excavating too close to the toe of a pile bearing in soft clay, in which case the clay will flow and the pile sink until it re-establishes its bulb of pressure in the confined clay further down. Experience in a large number of cases, many of which cover piles bearing in so-called quicksand, shows that excavation can be made within two feet of the footing without serious settlement, but that five or six feet should be established as the safe limit in soft ground.

Where piles are tested to 50 or 60 tons—assuming that as being at least 50 per cent above the bearing load—the bulb of pressure is not destroyed by the release of pressure, as assumed by Mr. White, nor is the soil, within the small area stressed, sufficiently elastic to show any appreciable rebound. There is, however, a measurable and in long piles a very appreciable rebound due to the elasticity of the pile body itself. Wherever possible this rebound should be prevented, as suggested, by wedging or by other means. There are many instances, however, where it is not practicable to hold the pile when tested—because of the absence of the permanent load or because of interference between the bottom of the load and the pile head where special construction prevents the maintenance of a strut in place. The inference should not be drawn however that the nonmaintainance of a percentage of the test load will cause the pile to settle. This is not the case, as the excess test is the real prevention of settlement under the bearing load.

The possible danger of considering earth or soil as a solid in relation to the possible pressure exerted by it on trenches or tunnels is that too much reliance may be placed on cohesion, and weak bracing or even inadequate structures may result, as is sometimes the case in disintegrated rock or clay.

As a matter of fact all soil, whether solid rock, massive clay, or granular particles cohering (as in normally dry sand) does break or tend to break and exert pressure on confining structures wherever the operations are relatively large enough. That is, solid rock when cut by a trench sufficiently deep or a tunnel sufficiently wide will break to certain lines and the resulting pressure must be designed for as if the mass were noncohesive and granular. Nor does it matter whether these breaks occur in rock, clay, or sand; they are constant and similar under similar conditions, each obeying its own fixed law. Nor does it matter whether or not these lines or planes as they occur or tend to occur are called breaking lines or pressure lines or lines of rupture or lines of repose; they are well defined and capable of being measured under proper conditions. Within these lines or planes certain areas will cause pressure on a vertical face and other areas will cause pressure on a horizontal face.

While the writer measures these pressures in entirely different terms from those of the old masters, he still adheres to the good old terms: plane or angle of repose, dividing the breaking (or tending to break) from the unbroken; and plane or angle of rupture, dividing the areas causing horizontal and vertical pressures. The determination of the relations of these planes on a scale sufficiently large to be conclusive appears to the writer to be the big unsolved problem.

The writer wishes to emphasize again the fallacy of observations made on shallow trenches or small tunnels, frequently giving exaggerated ideas of the value of cohesion and suggesting that formulated results based on slope or pressure lines are erroneous. The writer has himself endeavored to formulate the pressures resulting from these breaks or tendencies to break, and has published elsewhere the results, which are too long to publish here.

To conclude then, it seems perfectly clear to the writer that normally dry earth or soil, including rock, should be treated as what it actually is or may become under operations on a small or large scale, that is, as either a monolithic or a granular mass. With this clearly before us, and the realization that pressure, whether from its own or from an extraneous body or bodies, is transmitted laterally by or through soil, we find that the reconciliation of fact and theory may be accomplished. And thus we come to a better understanding of many facts, such as that in normally dry ground (a) pressure is not accumulative vertically downward, (b) there is no tendency for the bottom of a tunnel to bulge up or for the earth at the bottom of a trench to exert any but nominal pressure, (c) the arching properties of granular materials are absolute as long as the material below the arch is prevented from disintegrating, (d) the base of a pile or foundation establishes and maintains under pressure a so-called bulb (or equivalent) of pressure, and (e) the reverse explains the picking up in driving of a shallow sand plug by a hollow pile, which may sometimes stop its progress until cleared out. Finally, the action of pressure in grain bins is more easily comprehended.

J. C. MEEM,
Brooklyn, Jan. 18. Engineer for F. L. Cranford, Inc.

The Hydraulic Jump and Critical Depth

Sir—I read with much interest the novel and comprehensive article by Julian Hinds on the "Hydraulic Jump and Critical Depth" in your issue of Nov. 25, 1920, p. 1034. This original exposition explains a development of hydraulic theory which seems to have only recently been applied in practice, but which apparently is destined to have a wide field of usefulness when it is once well comprehended by hydraulic engineers. I am glad to know that the *Engineering News-Record* can still publish such articles

A consideration of critical depth and critical velocity seems to be applicable only to open channels and to flow at relatively high velocities. Perhaps this is why the subject has not been exploited before; because in natural channels

or in artificial channels in earth ordinarily all velocities are much below the critical velocity.

It is not apparent why in this study it is necessary to consider the so-called alternative stages. The critical depth and critical velocity seem to be most easily defined as the depth and velocity existing when the velocity head equals half the average depth in the cross-section. For a given quantity of water flowing, and a given channel cross-section of any of the ordinary shapes, the critical depth and velocity may be easily determined by trial by successive approximations.

Although the alternative stages are connected by a certain mathematical relation, this does not seem to correspond to any useful hydraulic relationship. A channel, uniform in cross-section and slope, carrying a given flow for any distance at one stage could not carry the same flow at the so-called alternative stage. If the channel is not uniform in cross-section and slope then, while it is conceivable that the flow could pass by means of the proper transitional channel from one to the other stage, it would during the transition have to pass through all the intervening stages, and it is not evident that the final stage would have any more practical connection with the original stage than would any of the intermediate stages.

Perhaps I do not fully comprehend the matter. But it appears to me that the essence of the problem is to determine for any given case of flow whether the velocity is greater or less than the critical velocity, and how much it differs from the critical velocity. These having been determined any desired modification of the flow can be considered. The so-called alternative stage seems only a matter of accidental mathematical relation.

It appears that there is an ample field here for further investigation. Additional practical applications of the principles relating to critical flow, the extention of the subject to covered channels, the consideration of channels having more than one critical depth, all offer inviting fields of study which it is hoped engineers will find time nad opportunity to develop more fully. S. M. WOODWARD,

Department of Mechanics and Hydraulics,
Iowa City, Jan. 6. State University of Iowa.

Post Offices Principal Work of Supervising Architect

Sir—In *Engineering News-Record*, Dec. 20, 1920, p. 1273, appeared an article on the proposed National Department of Public Works by Lieut. Col. C. O. Sherrill.

Col. Sherrill's principal argument against the bill is that the heads of departments should have entire charge of carrying out the functions of their respective branches of the government in whatever field they may extend; that they should employ their own engineers and technical men, if such are necessary, the technical work so performed being only incidental to the functioning of the department as a whole; that this is the present arrangement of governmental activities and should continue. Whereas, if the proposed bill became a law, the various department heads would have to apply to the Secretary of Public Works for services of this nature, thus subordinating a portion of their own department to his.

In the article in question, the following paragraph appears:

"The example most frequently given by the Department of Public Works advocates of the inconsistency of the present arrangement of governmental activities, is that of the Supervising Architect's Office in the Treasury Department. The real reason why this is under the Treasury, rather than any other department, is that this department is the largest governmental user of public buildings in our cities, for custom houses, sub-treasuries, Internal Revenue Offices, Federal Reserve Banks, etc. What is more appropriate than that the Secretary of the Treasury should direct the construction of the buildings he needs in his business?"

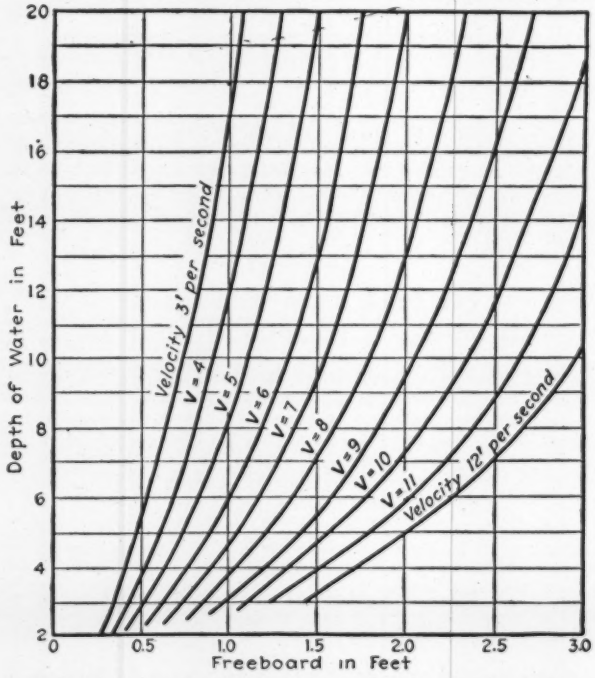
Somehow Col. Sherrill neglected to mention that over 95 per cent of the work of the Supervising Architect's Office is the construction of post offices throughout the country, not for the Treasury Department, but for the Post Office Department.

Therefore, under the existing conditions, which the opponents of the Public Works Bill argue should be maintained, when the Postmaster General wishes buildings constructed for the use of his own department, he does not engage his own engineers and architects, but, in the absence of a Department of Public Works, he does subordinate a portion of his own department, and a fairly important portion too, to the Secretary of the Treasury. J. A. CLIFF,

Structural Engineer, Office of the Supervising Architect.
Washington, D. C., Jan. 7.

Freeboard Allowance for Canal Linings

Sir—The attached chart, showing in terms of depth of water and velocity, the "freeboard," or height above normal water surface to which concrete irrigation canal lining should be carried, is based mainly on existing practice. There appears to be no standard practice with respect to this detail, existing canals under practically identical conditions bearing widely different allowances for freeboard. It is realized that factors other than the two mentioned



may influence a decision on the proper amount of freeboard to allow, but in nearly all cases the principal factors are depth of water and velocity, and it seems that it may be possible to work up a satisfactory empirical formula along the lines indicated by the chart.

The publication of this chart may bring comments from engineers with experience in this line of work which will be a valuable addition to the published data on the subject. The subject merits consideration, since the allowance for freeboard makes quite an appreciable percentage of the total cost of a canal.

Seattle, Dec. 19, 1920. CHARLES P. DUNN.

Railroad Rate Increases in England

As noted recently in *The Engineer*, London, railroad rates in England have advanced approximately 100 per cent above the 1913 level. Last July a further increase of 16⅔ per cent—making a total of 75 per cent over the pre-war rates—was made in passenger fares in addition to advances in the price of season and traders' tickets. More recently the Rates Advisory Committee report has been published, containing recommendations as to the raising of £53,500,000 additional necessary to operate the roads without loss.

NEWS OF THE WEEK

New York, January 27, 1921

Am. Soc. C. E. Directors Submit Annual Report

Total Membership on Jan. 1, 1921, Was 9,907—Curtailment of "Proceedings" Reduces Publication Costs

On account of limitations of space it was necessary to omit from last week's report of the annual meeting of the American Society of Civil Engineers a summary of the reports of the Board of Direction, the acting secretary and the treasurer. A digest of these reports is presented herewith:

The annual report of the Board of Direction for 1920 showed a total membership on Jan. 1, 1921, of 9,907, a net increase of 499 during the year. The total number of applications received in 1920 was 1,285 of which 960 were for admission and 325 for transfer.

The Engineering Societies Library received during 1920 a total of 2,337 volumes, 1,304 pamphlets and 244 maps and plans, making a total of 153,320 now in the permanent collection. Expenditures for the work of the library totaled $26,000. The total attendance for the year was 23,788, an average of 78 daily.

The Engineering Societies' Service Bureau was conducted jointly by the secretaries of the four founder societies. Its work has been administered at a total cost to the four societies of $12,431. The total number of men registered during the year was 2,171 and the number placed, including those not registered, was 1,579.

There exist four special committees as follows: Bearing value of soils for foundations; stresses in railroad track; highway engineering, and bridge design and construction. The board authorized a special committee on research, a committee on amendments to the constitution, and a committee on external relations of the society, its report to be reviewed by a committee of past-presidents.

Beginning with the August number of *Proceedings* changes were made in the type face and size of page and papers were published by abstract only in order to reduce expenses. This plan has saved the society $6,500 during the half year. The net expenditure for publications in 1920 was $45,309, this figure covering mechanical costs only.

For the year ending July, 1919, prizes were awarded as follows:

Norman Medal to William Barclay Parsons for paper, "The Cape Cod Canal"; J. James R. Croes Medal to D. B. Steinman for paper, "Stress Measurements on the Hell Gate Arch Bridge"; Thomas Fitch Roland Prize to

(Continued on p. 188)

Pier Failure Wrecks Two Spans of Concrete Arch Bridge

Two spans of the Third Street bridge across the Miami River at Dayton, O., failed shortly before 6 p.m. on Jan. 21, due to sudden subsidence of a section of the pier between. No lives were lost, although many persons were on the bridge at the time and three were thrown into the river, together with two automobiles. A street car had passed over just before the failure, and another was stopped just short of the collapsed part of the roadway.

The arches involved in the failure are the second and third from the east or Dayton bank. They span 90 ft. and 100 ft. respectively, and spring at a level of 14 ft. above original river bottom; the pier was founded on a compact gravel 9 ft. below original river bottom. At springing line the pier is about 10 ft. thick. Its footing is about 21 ft. by 80 ft.

Examination shortly after the collapse showed that the pier sheared off clean near the line of the outer rail of the near or westbound track. The end or north portion of the pier went down about 3 ft. No evidence of damage to the bridge outside of the two arches resting on the pier is reported.

An investigation of the failure has been initiated by the engineers of the Miami Conservancy District and the engineering department of the city of Dayton.

The bridge was built in 1904 and 1905, to designs of the Concrete-Steel Engineering Co., by the Hogland & Kline Construction Co. It is of the Melan type, and comprises seven spans 80 to 110 ft. long in the clear, with rise of 14 ft. 3 in. to 9 ft. 8 in. The clear width of bridge is 62 ft. A description was published in *The Engineering Record*, Mar. 24, 1906, p. 386.

Interstate Drainage Controversy in Supreme Court

A final hearing in the Dakota-Minnesota drainage case has been held before the U. S. Supreme Court, and the matter now awaits the court's decision. The essential part of the suit is an engineering question as to whether extensive construction of large ditches through level country not previously drained has increased the flood damage below; and if so, what are the rights of the riparian owners along the overburdened stream. This case comes before the Federal courts because the construction work was in Minnesota and the damage claims are in South Dakota and North Dakota, which states combined in a suit against Minnesota.

Iowa Engineers Organized for United Effort

Annual Convention Brings Out Record Attendance of 400—Three Sections Meet Separately

More than 400 engineers and their friends attended the meeting of the Iowa Engineering Society, Jan. 18, 19 and 20 at Des Moines, and more than 40 exhibitors were in evidence. It was the largest attended meeting of the kind Iowa has ever seen. The new constitution sectionalizing the work, districting the state and including local clubs, together with the licensing program put through by the society is accountable for the unity and solidarity of the profession in Iowa. Simultaneous sessions of the three sections, municipal, drainage and highway, filled the respective rooms to overflowing, although they would have been ample in size in previous years for the whole society.

Of actions taken the most important was the unanimous vote without discussion to become a charter member of the Federated American Engineering Societies. The State Legislature was memorialized to provide for a sanitary and water survey and to take care of the poorly equipped geological survey. Standard forms for engineering contracts, paving, sewers and waterworks were submitted by a committee of that name headed by M. G. Hall.

The most notable investigation undertaken during 1920 was that of the committee on compensation of which L. A. Canfield is chairman. The remuneration of men in other professions, doctors, lawyers and dentists, was compared with the income of engineers. Of the 1,500 inquiries sent out, 35 per cent were answered. The average curve of the engineers showed a steady increase, passing that of the dentists after twenty-two years of practice, the lawyers after twenty-five years and the doctors after twenty-seven years. Previous to these dates the engineers received a materially smaller income. A minimum schedule was suggested, based on the period of service for the various classes of engineering positions.

C. H. Young's report of the committee on legislation illustrated the functioning of the new type of organization. All legislative effort pertaining to engineering in the state is directed through the committee. A code revision of all laws of the state is under way and the committee acted as a clearing house for laws pertaining to engineers, passing these down to the various sections, clubs, districts or branches of national societies interested. When

commented upon, the laws, with suggestions as approved, were returned to the committee which acted in conjunction with a committee from the Des Moines Engineers' Club in presenting the information to the code revision committee. Assistance was rendered to the Department of Public Works movement; also for the Nolan bill increasing appropriations for U. S. Patent Office employees.

A new committee on publications was authorized to pass on papers and to ascertain if the number of exchanges with other organizations might not be cut down.

Of twelve organizations in the state, nine have decided to become district clubs of the society. They are as follows: Clubs of Ames, Davenport, Des Moines, Iowa City, Sioux City, Spencer and Webster City, Waterloo Technical Society and the Southwest Iowa Engineers' Club of Atlantic. Clubs at Cedar Rapids, Boone and Mason City still have the matter under consideration. These locals brought in 140 new members, raising the total membership to 515. The society raised $2,230 in 1920 and closed the year with $206 on hand, less by $350 than one year ago.

Although the convention was three days long, only two general sessions were held, one for the business of the society and one in which business problems of the profession were discussed. The drainage section held three technical sessions with six papers and eight topical discussions, the highway section heard two papers and the municipal section four. A new section for electrical and mechanical engineers was authorized following a petition from eighteen members.

The officers elected for the ensuing year are as follows: President, J. H. Dunlap; vice-president, Alvin Le Van; new director, J. D. Wardle. Of the municipal section, F. P. Wilson is chairman, P. K. DeVoe, vice-chairman and F. H. Austin, secretary; of the drainage section, C. E. Gross is chairman, J. L. Parsons, vice-chairman and R. G. Austin, secretary; of the highway section, H. W. Thompson is chairman, L. M. Martin is vice-chairman and C. W. Eby, secretary. The successor of Mr. Dunlap, who has served the society as secretary since 1914, will be chosen by the board of directors.

Am. Soc. C. E. Convention in Houston

The next annual convention of the American Society of Civil Engineers will be held in Houston, Texas, April 27. The decision was reached by the new Board of Direction at its meeting Jan. 19. It was indicated at the annual meeting in New York City last week that one of the most important matters to be considered at the Houston convention will be a new constitution for the Society on which a committee headed by Col. Peter Junkersfeld has been at work for some time past.

Transportation Problems Engage Federal Highway Council

The warning by S. M. Williams, chairman of the Federal Highway Council, against establishing highway transportation beyond highway development, is finding lodgment in traffic circles. Prominent traffic men co-operating with the council are now taking hold of the transportation problem with a determination to insure the construction of roads around industrial and commercial centers that will prevent a return to congested conditions.

They do not propose, according to C. W. Reid, manager of the transportation bureau of the council, to be caught unprepared when the traffic tide begins to rise again. "For this reason," said Mr. Reid, "many traffic managers throughout the country are going to give a closer study and more determined application to the motor truck terminal zones as a co-operating branch of the railway and express service." Now that the railway express merger has been approved by the Interstate Commerce Commission, it is the belief that the next great step forward will be to throw short haul tonnage to the motor truck as fast as the change can be brought about along practical lines.

Economic Service

The Federal Highway Council, according to Mr. Williams, is working upon the belief that the future development of any type of transportation will largely depend upon the economic service which that type may render the communities served.

"Admitting that the short haul freight is not a function of the railroads," Mr. Williams said, "and recognizing the necessity of relief to the railroads so that their equipment may be employed in the longer and more profitable haul, I do not feel that the public utilities commissions of the various states will be willing to relieve the railroads of that responsibility until the public is assured of a substitute that will give at least as satisfactory and dependable service. With the exception of a few instances the highways of our country are not in a position to assume the burden of the short haul now handled by the railroads, and therefore is it not time to begin the promotion of this subject from the bottom, rather than from the top?

Specific Traffic Needs

"I feel," Mr. Williams concluded, "that as a part of the important work of the council's transportation committee it will be necessary for its members first to analyze what intelligently constitutes the short haul. Second, they should ascertain, by intensive study, highway conditions in the various communities, with a view to encouraging the development of highways necessary to meet this specific traffic need. The entire work of the Federal Highway Council is based upon a policy that should support the transportation work.

Dinner for Leaders of Western Industry

To commemorate the thirty-fifth anniversary of the *Journal of Electricity*, the McGraw-Hill Co. of California has invited representative leaders in the development of western resources and their utilization in productive industry to be its guests at a dinner to be held Feb. 1 at the Palace Hotel, San Francisco.

Oregon Irrigation Congress

At the 10th annual session of the Oregon Irrigation Congress held in Portland Jan. 7 and 8, resolutions asking the state legislature to appropriate $10,000 for the sinking of an artesian well in the Fort Rock section of northern Lake County were passed. It is thought that a flow of water can be obtained at a depth of from 500 to 900 ft. to irrigate what would otherwise remain arid land.

A committee was appointed to confer with a like committee of the Oregon State Drainage Association looking toward the consolidation of the two bodies into one under the name of the Oregon Reclamation Association.

Fred N. Wallace of Tumalo, and J. Frank Spinning of Echo, were re-elected as president and secretary, respectively. Four vice-presidents for the four districts were chosen as follows: Harry W. Gard of Madras, Fred A. Phillips of Baker, C. C. Clary of Arlington and James Chinnock of Grants Pass.

National Civic Federation to Discuss Labor Issues

International, European and American labor problems will furnish the main topics for discussion at the annual meeting of the National Civic Federation, Feb. 14, 15, 16 at the Hotel Astor, New York City.

Am. Soc. C. E. Directors' Report

(*Continued from p. 187*)

O. H. Ammann for paper, "The Hell Gate Arch Bridge and Approaches of the New York Connecting Railroad Over the East River in New York City"; James Laurie Prize to F. W. Gardiner and S. Johannesson for paper, "Manhattan Elevated Railway Improvements"; Collingwood Prize for Juniors to Floyd A. Nagler for paper, "Obstruction of Bridge Piers to the Flow of Water."

There are at present 27 local sections and 8 student chapters.

Finances

The general balance sheet, as of Dec. 31, 1920, shows total assets of $1,241,081.22, total liabilities of $287,130.44, leaving in the reserve fund and surplus $953,950.78.

Receipts during the year, including balance of $27,920.65 on hand Jan. 1, 1920, amounted to $230,263.93; disbursements were $216,530.63, leaving a balance on hand Dec. 31, 1920, of $41,653.95.

New York Section, Am. Soc. C. E. February Meeting

In order to avoid a conflict with the annual meetings of the electrical and mining engineers the February meeting of the New York Section of the American Society of Civil Engineers will be held Feb. 9 instead of Feb. 16. Through an error, it was stated last week that the meeting date had been postponed from Feb. 16 to Feb. 23.

The subject of the meeting is "Light, Heat and Power," and the discussion will apply to the needs of the New York metropolitan district. The local sections of the mechanical, electrical and mining societies have accepted an invitation to attend the meeting and send delegates. The principal paper will be by Colonel William Barclay Parsons. It will be discussed by J. W. Lieb, vice-president, New York Edison Co., New York City; Frank Smith, vice-president, United Electric Light & Power Co., New York City; Farley Osgood, vice-president, Public Service Electric Co., Newark, N. J.; George Otis Smith, U. S. Geological Survey, Washington, D. C.; H. E. Skougor, consulting engineer, New York City; George Gibbs, consulting engineer, Gibbs & Hill, New York City; William Cullen Morris, engineer of construction, Consolidated Gas Co., New York City, and F. O. Blackwell, consulting engineer, Viele, Blackwell & Buck, New York City.

New Committees of Am. Soc. C. E. Are Named

The new Board of Direction of the American Society of Civil Engineers, at its first meeting Jan. 19, following the annual meeting of the society in New York, made the following committee appointments:

Publication Committee—A. M. Hunt, chairman; R. L. Humphrey, C. E. Grunsky, C. W. Hudson, C. C. Elwell.

Finance Committee — Clemens Herschel, chairman; John W. Alvord, Ira W. McConnell, Willard Beahan, J. S. Langthorn.

Library Committee — Francis Lee Stuart, chairman; R. A. Cummings, George G. Anderson, Carleton Greene.

Committee on Special Committees—A. P. Davis, chairman; Anson Marston, George H. Pegram.

Goethals Consulted on Ohio State Highway Work

The new governor of Ohio, Harry L. Davis, has been in consultation with Major-General George W. Goethals regarding a reorganization of the state highway department. During his campaign for office Governor Davis made the efficient administration of the state highway work one of his main issues.

Town Engineer Wanted

Applications for the position of town engineer are wanted by the Town Council, North Bay, Ontario, Canada.

Conditions Governing Wellington Transportation Prize

As announced in last week's issue the Board of Direction of the American Society of Civil Engineers has accepted *Engineering News-Record's* offer to establish an "Arthur M. Wellington Prize" to be awarded annually for a paper on any phase of the subject of "Transportation." The following letter addressed to the board under date of Dec. 15 explains the offer:

"For some time the staff of *Engineering News-Record* has contemplated the establishment of a memorial in honor of Arthur M. Wellington, former editor of *Engineering News* and author of the well-known book on railway location, entitled 'The Economic Theory of Railway Location.'

"After considering various proposals we have concluded that no memorial could be more fitting than the establishment, under the auspices of the American Society of Civil Engineers, of an 'Arthur M. Wellington Prize,' to be awarded annually for the best paper presented before the society on any phase of the science and art of transportation, whether by land, water or air.

"Accordingly, if it please the Board of Direction of the society, *Engineering News-Record* will be glad to establish a fund of $2,000, the annual income from which would constitute the material element of the prize referred to in the preceding paragraph.

"*Engineering News-Record* would make only two reservations regarding the award of the prize:

"1. That it be awarded only for papers on a transportation subject. Such a reservation, we believe, befits a memorial to a great transportation authority.

"2. That it be not restricted to members of the society. This reservation is made because the great advances in transportation in the future may be on water or in the air, specialties in which the members of the society do not normally engage.

"The usual discretion, of course, would be allowed the society's Committee on Prizes to withhold the awarding of the prizes in any year should they deem no paper offered worthy of the award. In that case the income should be added to the principal sum.

"Should the proposal herein contained meet with the approval of the Board of Direction check in the amount designated will be promptly forwarded."

Construction Division Men to Hold Reunion

The annual reunion of those who were identified with the Construction Division of the army during the war will be held at the Morrison Hotel, Chicago, Feb. 25 and 26. The afternoon of the first day and the morning and afternoon of the second day will be devoted to business sessions and the annual banquet will be held on the evening of Feb. 26.

Engineering Societies Hold Hydro-Electric Symposium at Philadelphia

Under the auspices of the Engineers' Club of Philadelphia the Philadelphia sections of the American Society of Civil Engineers, the American Institute of Electrical Engineers and the American Society of Mechanical Engineers there was held in Philadelphia on Jan. 21 a symposium on hydro-electric development and distribution. There were two sessions, one in the afternoon and one in the evening with a dinner in between. In the afternoon some of the recent developments in the hydraulic machinery field were discussed by Frank H. Rogers, hydraulic engineer, I. P. Morris Co., Philadelphia; Norman R. Gibson, hydraulic engineer, Niagara Falls Power Co.; R. D. Johnson, consulting engineer, New York City, and L. F. Moody, consulting engineer, I. P. Morris Co., Philadelphia. In the evening John L. Harper, chief engineer, Niagara Falls Power Co., showed a number of moving pictures of Niagara Falls and the construction of the recent extension to plant No. 3 of his company, at the same time defending a further diversion of water at Niagara for power purposes. D. B. Rushmore, of the General Electric Co., completed the evening with a discussion of the electrical features of hydro-electric power.

The symposium was one of a number which are intended to be held in Philadelphia under the joint auspices of the various engineering societies there, most of them to be devoted particularly to engineering features of interest to Philadelphians in order to bring before the people of the city the engineering problems of the city and at the same time to lead to a better understanding among the branches of the profession of the problems of the other branches. While the present meeting was devoted entirely to hydro-electric practice the predominance of local talent, particularly of local manufacturers, in the program, emphasized Philadelphia's relation to the industry rather than the industry itself.

Mr. Rogers' paper, entitled "The Modern Hydraulic Turbine," is a review of the present status of turbine design. It states that the important requirements today are (1) high power units, (2) high speed, (3) high efficiency, (4) reliability and (5) durability. He pointed out particularly the necessity for reliability and long life, because of the high first cost of the installation. A turbine might run successfully and efficiently for two years, say, and at that time have such a breakdown as to shut down the plant for a long time and thereby cause not only the cost of replacement but the loss of delivery of current. The paper refers, too, to the detailed design of intakes, canals, forebays, penstocks, valves, etc., and describes the testing plant for wheels at the plant of the I. P. Morris Co. in Philadelphia. The

paper notes, too, the importance of specific speeds. For low head high specific speeds has to be used, which results in high velocity of the runner discharge, thus making the draft-tube design of greatest importance. For high head low specific speeds are used, which would result in a relatively larger runner diameter, but gives greater trouble with water leakage at the runner seals and friction of the runners.

Mr. Gibson's paper was a description of his new method of water measurement and its application in the tests of the large turbines of the Niagara Falls Power Co. His method depends upon a record of the change of the pressure occurring in a pipe under head, this change being necessarily a measure of the change in velocity, so that in a given section the pressure changes indicate the volume discharge change.

Tests were carried out at the hydraulic laboratory of Cornell University which demonstrated the accuracy of the method to within very close figures and it was then adopted to test the flow in the Niagara Falls turbines and has been accepted by the government as the measure of the use of the water of the Niagara River. Mr. Johnson devoted practically all of his time to a description of his well-known surge tanks. Mr. Moody pointed out a number of the newer advances in hydraulic turbine design. These include the construction of the flow in the turbine as a continuous vortex which has led to the adoption of various draft-tube arrangements whereby the tube is kept in an axial relation to the turbine and the velocity of the discharge water reduced in circumferential lines. The leading types of such devices are Mr. Moody's type and one called the hydraucone, developed by Mr. White, of the Allis-Chalmers Co. The same whirling condition in the water in passing through the turbines has been utilized, too, in Mr. Moody's studies in the development of a propeller type of turbine, small models of which have been tested for some time in the I. P. Morris laboratory. A more radical innovation was proposed by Mr. Moody for low-head plants where high specific speed is required and where the consequent long draft tube is sometimes difficult to place. For such a condition he suggests the reversal of the turbine that is turning it upside down, making an upward flow wheel, in which case the draft tube could go below low water with a rising draft tube which would be dammed from the clear water by a siphon-like bell designed for such a layout. It is not stated that any such construction is contemplated.

The meeting was very well attended, there being some 700 to 800 men present at the two sessions and nearly that number at the dinner. It was presided over by Guilliaem Aertsen, president of the Engineers' Club of Philadelphia.

New Design for Belle Isle Bridge To Be Prepared

(From Engineering News-Record's Correspondent)

A resolution has been adopted by the Detroit City Council, providing for the preparation of plans for a reinforced-concrete arch bridge in lieu of the steel cantilever bridge faced with concrete for which detailed plans have been prepared and the construction of which has twice been advertised for bids. Plans for the reinforced-concrete bridge are to be prepared by D. B. Luten, of Indianapolis.

In introducing the resolution Councilman Bradley pointed out that bids on the original design accepted by the city show conclusively that the cost of such a bridge will greatly exceed the sum of $3,000,000 made available by vote of the people on April 7, 1919. It has been suggested that the question of providing additional funds through a bond issue be submitted to the people at a future election, but this would involve further delay, and it is considered desirable, in view of the large amount of unemployment existing in the city that all necessary public work should be put under way as soon as possible.

A reinforced-concrete arch bridge of the same general design, appearance and capacity as the official plans provide has been proposed to be built within the amount remaining in the Belle Isle bridge fund. It is stated that the construction of such a bridge involves the immediate and ultimate employment of practically 50 per cent more labor than a steel bridge. The construction of such a bridge can be begun immediately, using materials which can all be obtained locally and it appears that the construction of a reinforced concrete arch bridge can be effected in approximately one year less time than required for a steel bridge.

The plans and an estimate of the cost of a bridge to be built according to these plans to be prepared by Daniel B. Luten are to be prepared and submitted without cost to the city and are to be submitted to the Common Council before they are referred to Esselstyn, Murphy & Hanford, the engineers now in charge of the design and construction of the Belle Isle bridge.

Calder Urges Establishment of Trade Schools

Senator William M. Calder, chairman, Senate Reconstruction Committee, has recently sent letters to the Governors of all the states, urging the establishment of Trade Schools in order to provide sufficient skilled workmen in the Building Trades to take care of future building. The survey recently made on housing conditions by the committee of which Senator Calder is chairman, has engendered a belief that something must be done quickly to interest young men in the building trade.

Public Works Construction Asked as Relief for Unemployed

In his report upon the unemployment situation in Canada, the executive of the Dominion Trades and Labor Council, urges all labor unions throughout the country to assist in a revival of construction. To avoid unemployment which promises to be serious unless something is done, the report urges upon labor organizations that they impress upon all employers the necessity of retaining as many workers as possible, if need be through reduction in hours, though make public the actions of employers who use the period of depression to lengthen the hours of work and decrease the wages accordingly. Other suggested means to defeat unemployment are active resumption of public works construction, increased road construction, clearing of brush land, construction of public buildings, etc.

St. Louis Building Trades Plan Price Inquiry

An inquiry into the high cost of building materials and the business practices of material dealers and manufacturers with a view to requesting a grand jury investigation, has been undertaken by the building trades council of St. Louis, through its board of business agents. The council is composed of fifty-two labor unions.

The business agents will report the undertaking to their local unions and enlist the services of all workmen in the building trades to help gather evidence, according to Maurice J. Cassidy, secretary of the council. The business agents will report the progress of the investigation from time to time at the regular meetings of the board. It is said the investigation was projected in the belief that material dealers and manufacturers are holding up a building program for St. Louis by restricting competition through trade associations.

Sixty of Alleged Plumbing Ring Indicted

A blanket indictment was handed down January 20, accusing approximately sixty master plumbers, who operate as individuals or firms, of conspiracy under the Donnely Anti-Trust Law. The charges were made on the basis of evidence revealed during the recent investigation of the building industry in New York City, by the Lockwood Joint Legislative Housing Committee. The names of the defendants were withheld.

Builder Opposes Wage Cut

At the recent annual convention of the Ohio State Association of Builders Exchanges, F. G. Webber, New York City, Secretary of the National Building Trades Employers Association, issued a plea that the employers not reduce wages at this time, and also intimated that best results could be secured from laborers through an attempt to get them to do a bigger days work.

Wage Adjustments Affect Many Industries

Revisions Relate to Rates of Pay and Hours of Work—Five-Day Week in Minneapolis

A wage reduction of 25 per cent, effective Jan. 17, was made recently by the Master Builders Trade Alliance of Danbury, Conn. The reduction affects steam fitters, painters and electricians. Carpenters and bricklayers will not be affected because of existing wage agreements.

Announcement was made recently by officials of the Minneapolis, St. Paul and Sault Ste. Marie R.R. that shop employees in Minneapolis have been placed on a five-day week. Approximately 1,400 men are affected. Since Sept. 1, 1920, 1,250 employees have been laid off by that company.

Officials of the Toledo & Ohio Central R.R. announced, Jan. 8, a reduction of approximately 35 per cent in locomotive repair forces and 45 per cent in car repair forces on the entire system.

The New York Air Brake Co., one of the largest industrial employers in Watertown, N. Y., has cut the wages of its employees 10 per cent. The new wage scale is effective from Jan. 10.

Approximately 4,000 employees of the Public Service Railway Co., of Newark, after being apprised of the financial condition of the company, accepted, Jan. 13, an agreement whereby the basic working day is increased from nine to ten hours. It is estimated that the company will save $200,000 annually by the new agreement.

The Kalamazoo Brick and Stone Masons Union has voluntarily lowered the wage scale of its members from $1.35 an hour to $1.25 an hour. Reasons for this voluntary reduction given are the decline in living costs and a hope that stimulation may be given building, resulting in decreased unemployment.

After being idle for a month, the Savage Arms plant in Utica, N. Y., resumed operations Jan. 10. No reduction is made in wages but the basis of pay is now nine hours instead of eight.

The New Jersey Zinc Co., Palmerton, Pa., made a 10 per cent cut in wages and eliminated an 8 per cent bonus system Jan. 15. The plant, however, will operate at full capacity, say recent press reports.

According to an announcement made Jan. 22 the Erie R.R. is making a further reduction in payrolls by working office, yards, stations and other forces five days a week, except where the safety of property is involved. The reduction is to be put into effect at once.

Chicago Builders and Labor Leaders Indicted

Violation of the Sherman Anti-Trust Law is charged in the indictment of forty-seven labor union chiefs, mill owners and carpenter contractors, which was returned January 21, by the Federal Grand Jury in Chicago. In a special report the Jury characterized building conditions in Chicago as deplorable, recommending a thorough investigation of the entire building trades industry. An agreement entered into by the mill men, carpenter contractor association and members of the building trades in 1918, providing that only union-made materials could be used on jobs done by union labor, was the basis for the Grand Jury action.

Sand and Gravel Men Fined

Fines totaling $40,000 were imposed upon four sand and gravel corporations and eleven individual sand and gravel dealers by Judge Learned Hand, of the United States District Court, after they had pleaded guilty to a violation of the Sherman Anti-Trust Law. The indictments against the sand and gravel producers were found on Dec. 29, upon evidence submitted by special federal prosecutors. Judge Hand signed a decree dissolving the sand and gravel dealers' Board of Trades, the organization through which prices were alleged to have been fixed and maintained. The names of the four defendant corporations were given in *Engineering News-Record*, Jan. 6, 1921, p. 46.

Fifteen Thousand Out in Boston Building Trade Strike

Failure to agree on a basic wage scale has caused a strike of approximately 15,000 men in the building trades in Boston. All construction work which is being done by members of the Building Trades Eemployers' Association was stopped Jan. 20 as a result of this strike. Union officials maintain that an offer was made by them to sign a wage agreement at the old basic rate of $1 an hour for journeymen, whereas the secretary of the employers' association asserts that such an offer was made to the unions who refused it, the employers thereupon announcing a wage reduction, becoming effective Jan. 20, to a basic scale of 90c. per hour for journeymen.

Chicago Building Tradesmen Vote Continuance of $1.25 Scale

The Chicago Building Trades Council, in a recently issued statement, set forth reasons why the thirty-two unions affiliated with the Council voted not to accept any reductions in their present wage scales within the next three years. The union business agents recently met and voted to insist on a continuation of the present $1.25 an hour wage for union building workers. The reasons given are that union labor has already suffered, inasmuch as wages have not kept pace with the rise in prices of food stuffs, clothing, etc.; and that the ranks of the building trades have been decreased approximately 35 per cent within the last few years, owing to a desertion to more remunerative employment. Along with this insistence upon the continuation of the present wage scale goes the demand by all union labor leaders, that skilled workmen give a full honest day's work, failure to do so carrying with it severe disciplining by the workmen's organization.

ENGINEERING SOCIETIES

Calendar

Annual Meetings

AMERICAN ASSOCIATION OF ENGINEERS, Chicago; seventh annual convention, Buffalo, N. Y., May 9, 10 and 11.

AMERICAN CONCRETE INSTITUTE, Detroit; Chicago, Feb. 14-16.

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York; Annual Convention, Houston, Texas, April 27.

ENGINEERING INSTITUTE OF CANADA, Montreal; Toronto, Feb. 1-3.

AMERICAN ROAD BUILDERS' ASSOCIATION, New York City; New Orleans, Feb. 9-12.

The Engineering Society of Buffalo, at a recent meeting, was addressed by Howard Richards and William C. Wilson regarding a bill which has been proposed in Congress compelling the use of the metric system of weights and measures in all commercial transactions.

The Minnesota Surveyors' and Engineers' Society will hold its annual convention at the Hotel Commodore, St. Paul, Feb. 21, 22 and 23.

The Northwestern Section, Am. Soc. C. E., has inaugurated a series of three meetings to discuss the "Open Shop vs. the Closed Shop." The first meeting was held in St. Paul, Jan. 17, and was addressed by George W. Lawson. W. E. McEwin spoke on "Industrial Relations."

The Engineers' Society of St. Paul, Minn., at its annual meeting Jan. 10, elected the following officers: President, J. H. Mullen; vice-president, W. W. Walker; secretary, A. A. Sommerfeld; treasurer, W. N. Carey. The society now has 302 members.

The Memphis (Tenn.) Engineers' Club, at a dinner held Jan. 10, elected the following officers: President, Robert W. Gay; vice-president, J. H. Haylow; secretary-treasurer, A. S. Fry.

The American Water-Works Association, Canadian Section, will hold its first general meeting at Toronto, Ont., Feb. 4. At 10 a.m. will commence the

"get together" session with luncheon at 1 p.m. A paper "The Relation of the Water Supply to the Public Health" will be read by Dr. J. W. S. McCullough, followed by open discussion. Alexander Milne of St. Catharines, Ont., is chairman.

The Provincial Association of Contractors and Supply Dealers of Ontario will be held in Stratford, Ont., Feb. 15-17.

The Association of Professional Engineers of New Brunswick, Canada, at its annual meeting Jan. 14 at St. John, elected the following officers: President, C. C. Kirby; vice-president, W. H. Duff; councillor for St. John district, L. P. Vaughan; councillor for Moncton, H. S. Pickard.

PERSONAL NOTES

THOMAS F. LAWLOR, former president of the Board of Public Works, Poughkeepsie, N. Y., has been appointed superintendent of public works.

WILLIAM S. HENDERSON, for several years engineer of Washington County, Kan., has been appointed city engineer, Lawrence, and later, when the resignation of L. A. Quigley becomes effective, will become superintendent of the water plant.

CLARENCE MCN. STEEVES of St. John, N. B., has been appointed assistant engineer, Department of Railways and Canals, Ottawa.

W. J. KELLY has resigned as highway engineer, Walker County, Texas, to take charge of all road building in Trinity County.

MAJOR L. E. LYON, Corps of Engineers, U. S. Army, formerly military assistant to the district engineer at Norfolk, Va., has been assigned to duty as engineer of the Philadelphia district.

L. A. DUFRESNE has been appointed highway engineer for Calhoun County, Miss., where 50 miles of Federal Aid project surveys are being made.

N. L. SOMERS, for four and one-half years assistant to the works engineer, Algema Steel Corp., Sault Ste. Marie, Ont., will incorporate a company to engage in sales engineering and contracting and will specialize in power development, hydro-electric and transmission lines. His office will be in Toronto.

L. S. JEFFORDS, since 1910 with the Atlantic Coast Line R.R. and recently assistant engineer maintenance-of-way, second division, has been appointed engineer maintenance-of-way, of the Charleston & Western Carolina Ry.

GUY C. DUNN, formerly engineer of construction at Winnipeg of the Grand Trunk Pacific Ry., has been appointed office engineer, chief engineer's office, Eastern Lines, Canadian Northern Ry. at Toronto, Ont.

LANE, DAVENPORT & PETERSON is a newly organized architectural and engineering firm with offices in the Dime Bank Building, Detroit, Mich. Horace H. Lane has supervised the design and erection of numerous industrial plants and power houses, among which are the steel car plant and power house for the American Car & Foundry Co., the Delray power plant of the Detroit-Edison Co., and the $2,000,000 plant of the Eastern Car Co. near Halifax, N. S. H. D. Davenport is an architect and has been practicing a number of years in Grand Rapids and Detroit. A. A. Peterson is a structural engineer with several years' experience in the design of steel and reinforced concrete buildings; he has been associated with Mr. Lane for nine years in the design and layout of manufacturing buildings.

G. A. RUSSELL, formerly engineer of Geary County, Kan., has been appointed engineer of Pottawatomie County, Kan.

F. S. WILSON, an engineer of Rosedale, Kan., has been appointed a member of the city planning commission of Kansas City, Kan.

ANDREW LENDERINK, for nine years city engineer, Kalamazoo, Mich., has entered private practice as a consulting engineer with office in the Kalamazoo National Bank Building, Kalamazoo, Mich. He will engage in the preparation or review of designs, plans, specifications, and contracts for municipal work, the inspection of building and road construction and consultation on construction matters.

W. BINTZ, formerly structural engineer of the Flint, Mich., engineering department, has accepted a similar position at Lansing, Mich.

ELBERT REYNOLDS, for several years highway engineer for Jefferson County, Ark., has been appointed an engineer for the State Highway Commission under Herbert R. Wilson, recently appointed highway commissioner. He will continue to direct the highway work of Jefferson County.

SWIGART & EHRMAN, civil and hydraulic engineers, announce the retirement of H. N. Legreid from the firm.

JERRY DONOHUE of Sheboygan, Wis., has been engaged as city engineer of Hartford, Wis.

E. W. GUNGEL has been appointed chief inspector for the newly created smoke inspection bureau of Harrisburg, Pa.

ARTHUR S. TUTTLE, deputy chief engineer of the Board of Estimate and Apportionment, New York City, has been appointed chief engineer to succeed Nelson P. Lewis who recently resigned.

ALFRED E. KORNFELD, formerly manager of *Engineering News*, will sail Feb. 3 for a seven-months' trip through Europe, Egypt and the Holy Land. In the latter country he is to make a survey of industrial, business and financial conditions with regard to future colonization.

HERBERT S. SISSON, state commissioner of excise since 1917, has been appointed New York State Highway Commissioner, succeeding Col. Frederick S. Greene, resigned.

OBITUARY

EDMUND M. BLAKE, production engineer for Charles R. McCormick & Co., and president of the National Association of Railway Tie Producers, died in San Francisco on Jan. 12 after an illness of only a few days. Mr. Blake, who was a Harvard graduate, went to the Pacific Coast four years ago, where he had a prominent part in wood preservation activities. He took a keen interest in the commercial development of the timber perforating process and was instrumental in getting the first machine for timber perforation installed on the Pacific Coast. Up to a few days before his death Mr. Blake had been very busy with plans for the annual convention of his association, which is to be held in San Francisco the fourth week in January and over which he was to have presided.

MAX EVERHART SMITH, president of the Continuous Transit Securities Co. and long the foremost advocate of moving platforms for passenger transit, died on Jan. 23 at the age of 72. His most successful work was the development of the escalator.

ELMER FOLSOM, senior member of the firm of Folsom & Taylor, civil engineers, Bloomington, Ill., died at Los Angeles, Cal., Jan. 9, 1921. He was 58 years old. Mr. Folsom was for 14 years city engineer of Bloomington, Ill., retiring from that position in 1915 to enter private practice. Recently he has been representing the firm as engineer for the Bloomington and Normal, Ill., Sanitary District for sewage disposal.

F. S. WARDWELL, engineer and contractor, died Jan. 16 at Stamford, Conn. He was born in 1860 at Bucksport, Me. Early in life he was engaged in railroad construction work and built the streeet railway in Duluth, Minn. He came to Stamford about 20 years ago to undertake the work of widening the east branch of the harbor and to construct docks. He then made a specialty of waterfront construction. His work in Stamford included the construction of docks for the Stollwerck Co., a bulkhead for the Petroleum Heat & Power Co., docks for the Yale & Towne Mfg. Co. and the Luders Marine Construction Co. He has been engaged in numerous contracts for dredging and construction, including the construction of foundations for various bridges.